FEDERAL RESERVE BANK OF SAN FRANCISCO

WORKING PAPER SERIES

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August 2023

Working Paper 2023-26

https://www.frbsf.org/economic-research/publications/working-papers/2023/26/

Suggested citation:

Imbert, Clément, Joan Monras, Marlon Seror, Yanos Zylberberg. 2023 "Floating Population: Migration With(Out) Family and the Spatial Distribution of Economic Activity," Federal Reserve Bank of San Francisco Working Paper 2023-26. https://doi.org/10.24148/wp2023-26

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Floating population: migration with(out) family and the spatial distribution of economic activity*

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August 30, 2023

Abstract

This paper argues that migrants' decision to bring their dependent family members shapes their consumption behavior, their choice of destination, and their sensitivity to migration barriers. We document that in China: (i) rural migrants disproportionately move to expensive cities; (ii) in these cities they live without their family and in poorer housing conditions; and (iii) they remit more, especially when living without their family. We then develop a quantitative general equilibrium spatial model in which migrant households choose whether, how (with or without their family), and where to migrate. We estimate the model using plausibly exogenous variation in wages, housing prices, and exposure to family migration costs. We use the model to estimate migration costs and relate them to migration policy. We find that *hukou* policies protect workers in large, expensive, and high income cities at the expense of rural households, who use remittances to overcome some of these costs.

Keywords: migration, remittances, economic geography, spatial equilibrium.
JEL Classification: R12, J61, O15.

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1 Introduction

In the early 2000s, China experienced one of the largest internal migration episodes in history. Around 35 million rural migrants moved to cities between 2000 and 2005—a number that increased further over the subsequent years. As a result, cities in China grew by about 10 percent in only 5 years, with substantial heterogeneity across destinations: The cities that grew the most were the most expensive and least welcoming,[1] and migrants typically endured difficult living conditions there while leaving their children behind.[2] This massive movement of population was regulated by the *hukou* system, which imposes restrictions on rural workers and limits access to public goods at destination, most prominently health care and education.

In this paper, we investigate the role of migration costs in explaining why migrants disproportionately move toward expensive cities, why many migrants decide to leave their children behind, and the implications for the welfare of rural-born and urban-born households. Our main hypothesis is that the relative costs of migrating with the family, in part related to the *hukou* policy in the Chinese context, encourage many migrants to: (i) leave their children at origin, (ii) sort into select cities that pay high wages and appear unwelcoming to rural families; and (iii) remit generously to their children and other family members at origin. Testing this hypothesis is challenging: Migration decisions and migration policies are endogenous to economic conditions at destination; in general equilibrium, migration flows themselves influence housing and labor markets at those destinations; and existing spatial equilibrium models of migration do not consider the (endogenous) decision to migrate with or without family.

To overcome these challenges, we develop and estimate a model of family migration in spatial equilibrium. We proceed in four steps. First, we document a number of empirical facts using detailed census data on bilateral rural-urban migration and other aspects of the migration experience in China such as remittances, which we obtain from the nationally representative China Migrants Dynamic Survey (CMDS). We show that rural migrants disproportionately concentrate in high-wage, high-rent destinations relative to urban residents. This pattern is similar to what happens with international immigrants in the United States (Albert and Monras 2022): Rural migrants in China do not seem deterred by the high housing costs of large cities, presumably because they value what the high nominal wages in those destinations can buy *at origin*. Indeed, we also document that rural migrants leave part of their family at origin and demand low housing services

[1] The most important predictors of population growth across cities were nominal prices—wages and housing rents in 2000—and exposure to international trade. See Figure B.1 and Table B.1 in Appendix B.1.

[2] Fifteen million families decided to leave their children in villages, often with grandparents and other relatives (see Gao et al. 2022, looking at the effect of such migration patterns on the children left behind). This pattern of migration was more prevalent in large, expensive cities.

at destination, especially so in more expensive cities. In the cheapest destinations, rural migrants are as likely to live with their family as residents and only 20 percentage points more likely to be living in poor housing conditions. By contrast, rural migrants are 40 percentage points more likely to live without family and in precarious housing in the most expensive destinations. In line with this story, we show that migrants who decide to leave family members behind remit substantially more than others.[3] We take these facts as suggestive evidence that migration choices depend on wages and housing prices at destination, but also on the relative costs and opportunities of migrating with or without the entire family.

The second step of our analysis introduces these elements in a general equilibrium quantitative spatial model of location choice that tries to capture the essential forces behind the migration experience in China during the early 2000s. In the model, rural households, who are exogenously born in different locations, can decide to remain in their birthplaces or move across a set of urban locations characterized by different productivity fundamentals. As in standard spatial models, higher productivity cities can sustain a larger population, higher wages, and higher housing costs in equilibrium. Rural household heads decide whether to migrate, how (whether to leave family behind or not), and what destination to choose within a nested structure. The key mechanism in our model is as follows. If consumption were to take place at destination only, high nominal wages in a location would not necessarily make the location more attractive to migrants, since high housing prices (associated with large populations) would offset the high nominal wages. However, when a fraction of consumption takes place at origin, rural migrants have stronger incentives to locate in high-wage, high-rent locations than urban residents. This preference for high-wage, high-rent locations is reinforced among migrants who decide to leave family members behind, and hence, consume a higher income share at origin.

In the third step of our analysis, we estimate the main parameters of the model using plausibly exogenous variation in housing prices, wages, and relative migration costs. The model depends on a few key elasticities. We estimate the elasticity of substitution between consuming non-tradables at destination and remitting using variation from geographic constraints to housing development in the city limits, adapting empirical strategies proposed in Saiz (2010) and Harari (2020) to the Chinese context. We use this elasticity to compute price indices—and thus real wages—that are relevant to each migration mode (moving with or without the family) across destinations. We use variation in location-specific productivity, as computed from firm-level data prior to the

[3] In addition, we document a strong positive gradient of the share of income that is remitted with housing prices at destination, suggesting that immigrants substitute away from local expenditures when prices at destination are higher.

migration takeoff of the early 2000s, and exposure to international trade to predict which destinations can sustain higher real wages (Facchini et al. 2019). This variation allows us to estimate the elasticity of substitution across different destinations, both among family and non-family migrants. With these estimates, we can use the model structure to back out bilateral migration frictions as the residual that separates our model from the data (following methods developed in the spatial equilibrium literature, see Redding and Rossi-Hansberg 2018), and do so by migration mode.[4]

The previous steps discipline the choice of locations conditional on the migration mode. The next, crucial steps estimate how (and whether) households migrate. We exploit the gravity forces behind migration flows and the fact that destinations might be more or less "family-friendly": Intuitively, some origins are closer to expensive cities or cities with tough immigration policies, and hence, tend to experience larger shares of emigrants without children. We compute the (model-based) relative expected value of migrating with or without family from each origin and instrument this relative value of family migration in two different ways: (i) by leveraging exogenous variation in nominal prices to compute the real wages relevant to family relative to that for non-family migrants across destinations; and (ii) by using a historical predictor of *hukou* stringency at the prefecture level, which we both embed into the gravity structure suggested by the model. The final step estimates the elasticity of substitution between staying and moving away from origin locations. We rely on exogenous variation in the price of agricultural commodities combined with cropping patterns across origins, following Imbert et al. (2022).[5] This overall process allows us to estimate the three nests—whether, how, and where—of the migration model, an innovation in the migration literature that allows us to recover realistic migration costs.[6]

We identify the mapping between migration policy and these migration costs using exogenous variation in the level of grain reserves across prefectures before 2000. Local self-sufficiency in grain was indeed a major tenet of Mao Zedong's conception of development, partly owing to the severe constraints on the non-market allocation of resources in a country with limited communications and state capability (see, e.g., Riskin

[4]These methods have been used in the migration literature by Bryan and Morten (2019) and Tombe and Zhu (2019). However, these papers ignore the disproportionate costs that migration barriers might put on family migration. We show in Appendix E.3 that estimating bilateral migration frictions which are allowed to vary by migration mode is crucial in our setting. Note that the structure of our location model (with three nests) implies that we need to adapt these methods to a multiple-nest structure as we further explain in Appendix D.2.

[5]We close the estimation of the entire model by using emigration shocks across origins to estimate the production function of tradables and non-tradables in each destination, following a shift-share design close to the one developed in Imbert et al. (2022).

[6]A recent contribution discusses the issue related to the sparsity of the bilateral migration matrix, i.e., there are many pairs of origins and destinations without any (recorded) migration flow (Buggle et al. 2022). We develop a similar method, applied to our context in order to estimate our migration elasticities.

1981), and it remains a predictor of *hukou* stringency. We use this mapping to explore various counterfactuals. From these exercises, we learn (at least) three things. First, we show that the incentives to leave the family at origin and remit a substantial fraction of income are behind the observed spatial distribution of rural migrants in China. Without the possibility to remit, rural-urban migration would be 60% lower, a decrease almost entirely explained by the lower number of migrants without family sorting into select cities. Second, we show that current migration policies reduce the welfare of the rural population and benefit urban workers, particularly in large, expensive, and high-income cities. Adjusting migration barriers across migration modes downward to that of the median city would result in average welfare gains for (the more numerous) rural households of 2.7% and a decline in urban population welfare of 1.9%. Part of these costs, however, are mitigated because migrants can remit and substitute across migration modes. For example, reducing the family-specific component of the migration cost to that of the median destination would only moderately increase overall migration levels, given the strong substitution between leaving children behind and migrating with family. Finally, our model allows us to evaluate the 2014 *hukou* reform, which is sometimes described as a relaxation of migration restrictions. Our model suggests, instead, that the reform led to a modest decline in overall migration. Indeed, migration restrictions were lowered in locations that were not very attractive to migrants to begin with, and were tightened in typical migrant destinations. Through the lenses of the model, we conclude that migration policies in China are regressive: they benefit richer urban residents (and mostly those living in select cities) at the expense of poorer, rural households.

Overall, we think that our empirical evidence, model, and counterfactual exercises provide a novel framework to think about the role of migration frictions in shaping the spatial distribution of economic activity. Frictions crucially affect how households migrate and how they allocate their consumption across space, leading to a sizable "floating population." With this framework, we evaluate how Chinese migration policy affected internal migration and welfare. Beyond this context, we think that our approach is useful to understand the role of migration barriers and migration policies—which oftentimes impose disproportionate costs on migrants with young children—both internally, in other transforming economies than China, and internationally.

Related Literature Our paper is closely related to structural models of location choice which study the frictions to labor mobility (especially Bryan and Morten 2019, Tombe and Zhu 2019). Relative to this literature, we argue that it is important to incorporate family considerations into the migration choice in order to explain some empirical regularities, to obtain more realistic estimates of these mobility frictions, and to study the effect of migration policy. We also innovate in using various sources of exogenous variation both across origins and destinations to estimate a migration model with multiple nests. We argue that allowing for a rich structure of substitution across migrant choices is important for studying the effects of migration on the distribution of economic activity and overall migration.[7] More generally, our work also relates to numerous studies that explore the nature of frictions to labor mobility (e.g., Bryan et al. 2014, Adamopoulos et al. 2022, Brandt et al. 2013, Ngai et al. 2019, Gai et al. 2021, among others), and how these frictions shape aggregate outcomes (Hsieh and Moretti 2019, Lagakos et al. 2023).

Second, our work belongs to the body of research that emphasizes the ties that migrants keep with their origin, either through the study of remittances (see Yang 2011, for a review), family left-behind (see Antman 2013, for a review), or temporary migration (see Dustmann and Görlach 2016, for a review). Some of the closest contributions to ours are Lessem (2018), who estimates a location choice model that takes into account family location, and Albert and Monras (2022), who argue that the value of remittances affects the allocation of international migrants across American cities. Most of the literature focuses on international migrants while we study a new context, China, which had approximately as many internal migrants in 2010 as there were international migrants worldwide (210 million). Many of these migrants lived at destination without their family, with well-documented negative effects on the children left-behind (Li et al. 2015, Démurger and Wang 2016, Bai et al. 2018, Gao et al. 2022). This unique context enables us to consider migration with and without family between the full set of possible origins and destinations, and to exploit exogenous variation in local migration policies to study their effect on family migration and remittances in spatial equilibrium.

Third, our work is related to the large urban literature discussing the role of agglomeration and dispersion forces in disciplining city size (Tabuchi 1998). A particularly close contribution is Au and Henderson (2006a), which relates city size in China to migration barriers: (productive) cities are too small, with implications for aggregate productivity (Au and Henderson 2006b). The *hukou* registration policy indeed limits the overall reallocation of workers across space (Tombe and Zhu 2019, Gai et al. 2021). We bring to this literature the insight that migration policies also reduce the incentives of migrants to bring their family (as in Gao et al. 2022), which makes them less sensitive to congestion forces (as in Albert and Monras 2022). The same mechanism could apply to international migration restrictions, which may increase pressure on the most productive and congested destinations.

[7] Liu (2023) makes a similar point when studying how migrants substitute across modes of entry and occupation choices in response to US international migration policy using a structural model.

2 Data and institutional framework

This section presents the institutional framework, the main data sources, and descriptive statistics about migration patterns and living arrangements in cities. We leave to Section 5 discussions of the empirical strategy and data underlying the identification of the key parameters guiding migration choices.

2.1 Migration barriers in China

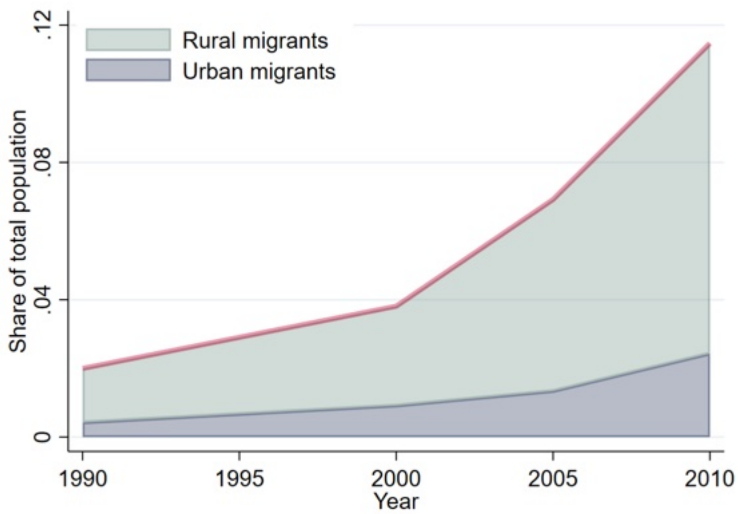
A distinctive feature of the Chinese context is the formal policy restricting internal migration: the *hukou* registration system, introduced in 1958. Between 1958 and the late 1970s, migration was effectively illegal in China unless mandated by the government. We can distinguish three major phases in the development of the *hukou* system since the beginning of the Reform era.

Before 2000, essential services such as food provision were still attached to the place of household registration, which severely curtailed individuals' ability to work outside of their places of origin for long periods of time (see, e.g., Zhang et al. 2018). Local food self-sufficiency—a major tenet of Chinese development following the disastrous procurement policies during the Great Famine (Meng et al. 2015)—implies that migration restrictions, which the central government was gradually devolving to local governments (Song 2014), closely mirrored grain reserves and were therefore heterogeneous across space (Cai et al. 2001). Figure 1 shows that migration between prefectures was limited and progressed at the pace of the liberalization of the urban economy.

From 2000 onward, food provision and place of registration became separate, but *hukou* type continued to condition access to public goods. Agricultural *hukou* holders would still have access to land at their registration place, while non-agricultural *hukou* holders would have access to welfare benefits and public services (e.g., enrollment in local schools, access to healthcare, urban pension plans, and subsidized housing). Due to the growing decentralization of migration policy in the Reform era, this general rule however masks considerable variation across locations in terms of *hukou* stringency, thus affecting the lives of agricultural *hukou* holders in cities. In some cities, migrants would need to return to their places of registration for basic services such as education and healthcare or would be charged higher fees at their destination, while access to public services would be more inclusive in others (Song 2014). Different access to services implies heterogeneity in migrants' likelihood to leave their dependent relatives behind.

In 2014, the central government partly reduced the discretionary nature of local registration policies and imposed a gradual relaxation of migration restrictions in lower-tier cities (Zhang et al. 2018): While the largest, "first-tier" cities raised migration barriers and second-tier cities did not experience systematic changes, cities below 1 million inhabitants typically loosened their restrictions.

Figure 1. Evolution of the migration rate by *hukou* type.



Notes: This figure represents the internal migration rate in China between 1990 and 2010, using Population Censuses (1990, 2000, and 2010) and the 2005 Mini-Census. A migrant is defined as an individual whose prefecture of residence is different from her prefecture of household registration. "Rural" and "urban" refer to agricultural and non-agricultural *hukou* holders, respectively.

One of our objectives is to investigate the effect of migration restrictions—their level but also their heterogeneity—on mobility between rural and urban areas and on migrant allocation across destinations. To measure *hukou* stringency, we follow Wu and You (2021) and use census data from 2000 and 2010, which record whether people were born in a different county, whether they were registered locally, and their registration type (agricultural or not). We compute the registration probability as the share of 15-64 year-old work migrants born in another county who were registered locally with a non-agricultural *hukou*. The proportion is 9% in 2000 and 12% in 2010. To measure *hukou* restrictions in the 2010s and quantify the large-scale reform of 2014, we rely on Zhang et al. (2018), who collected policy documents to create various indices of the ease with which migrants can obtain a local urban *hukou* across 124 Chinese cities, before and after the 2014 reform.[8] In Appendix A.2, we provide additional discussion of these measures

[8] Our baseline measure is a composite index, which summarizes different channels through which migrants could obtain local registration. The "employment" component of this index is most relevant to rural migrants (e.g., having a high-school degree, legal and stable residence and employment for a certain number of years, no criminal record, etc.). The other channels of *hukou* conversion, e.g., the purchase of a residential unit, investment, and eligibility for "talent" programs, are less likely avenues for unskilled rural migrants.

and combine them with auxiliary survey data on rural-urban migrants to shed light on the meaning of migration restrictions, in particular in terms of access to public goods.

2.2 Migration data

Migration flows Our main data source is the 2005 1% Population Survey (hereafter, "2005 Mini-Census"), which we use to measure migrant flows, returns to labor, and local prices.[9] The sampling frame of the "2005 Mini-Census" is the Public Security Bureau's 2004 population registry and covers the entire Chinese population, regardless of migration status. We use a random 20% extract of the micro-data to characterize each individual's migration situation, based on their current place of residence (the destination), their place of household registration or *hukou* (the origin), their *hukou* type (agricultural or non-agricultural), and their family situation. Information on the date of arrival at destination allows us to create a bilateral prefecture-level matrix of migration flows covering the period 2000–2005. Throughout the empirical sections of the paper, we define a migrant as an individual residing in a different prefecture from her prefecture of registration.[10] According to this definition, 5.6% of the Chinese population in 2005 were internal migrants, most of which (80%) originating from rural areas. Figure 1 puts these rates in perspective using similar data from the 1990, 2000, and 2010 Population Censuses. The migration rate series shows a structural break around 2000, corresponding to China's accession to the WTO (Facchini et al. 2015, Tombe and Zhu 2019), with low and slow-growing migration rates before 2000 and a rapid increase afterward.

Remittances and consumption across locations We capture remittances and the consumption of non-tradables at destination using the China Migrants Dynamic Survey (CMDS), a nationally representative repeated cross-section conducted by the National Health Commission every year since 2011 (Wang et al. 2021). We use the 2011 data on the amount remitted during the past year and divide it by yearly income to obtain an estimate of the share of income remitted by migrants to their households of origin. We similarly define consumption on non-tradables at destination. Although the periods covered by CMDS and the "2005 Mini-Census" do not overlap, we find a remittance share of 8.5% in CMDS, which is close to the percentage point difference between rural

[9] Our analysis also relies to a lesser extent on local population, local prices, local amenities, and migrant flows, as extracted from Population Censuses in 1990, 2000, 2010, and from the "2015 Mini-Census." We mostly use these alternative sources in robustness checks and/or to define baseline characteristics at the local level.

[10] Prefectures are the administrative level between provinces (which are immediately below the central government in the Chinese administrative hierarchy) and counties. There were 345 prefectures in China in 2005. Prefecture boundaries are subject to change; all the data used in this paper are mapped to the 2005 administrative boundaries.

migrants' and urban non-migrants' expenditure shares on non-tradables observed in the Mini-Census.[11]

2.3 Living conditions in cities and rural locations

Wages We use the "2005 Mini-Census" to measure wages in 2005. Information on wages is, however, not available in the 2000 Census; we therefore use average wages from the Statistical Yearbooks to measure returns to labor "at baseline."[12] The yearbooks distinguish between the wage in the "city" proper, i.e., the urban core of the prefecture, and the prefecture as a whole, i.e., including the rural hinterland. We leverage this distinction to measure destination and origin wages differently, using "city" and prefecture wages, respectively. One must bear in mind that origin wages reflect both the indirect utility of staying at origin and of moving within the prefecture, which we do not consider as migration in the empirical analysis.

Rents, housing conditions, and living arrangements We use the 2005 1% Population Survey to measure the cost of housing and to characterize housing conditions for both migrants and non-migrants in 2005. The data contain a rich housing module, which includes the monthly rent paid, as well as a wide array of housing characteristics. With these data, we create a measure of rental price at the prefecture level by averaging monthly rent by square meter across all tenants living in private accommodation,[13] and we create indices of poor housing conditions based on the description of housing materials and the types of kitchen, bathroom, and toilet in the dwelling.

We capture the living arrangements of households in cities by combining the household roster module of the 2005 1% Population Survey with information on marital status. Our main dichotomy is whether migrants live with any dependent family members at destination or leave them behind in their rural homes. Concretely, we define a family migrant as a household head living with a parent (father, mother, or parents in law) or a child, and the others as a migrant without family.[14]

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[11] We provide further descriptive statistics about migration patterns, migrant characteristics, their consumption behavior, and their access to public goods at destination in Appendix A.2.

[12] These data are compiled by the National Bureau of Statistics based on the Reporting Form System on Labor Wage Statistics, the National Monthly Sample Survey System on Labor Force, and the System of Rural Social and Economic Surveys (http://www.stats.gov.cn/tjsj/ndsj/2018/indexeh.htm).

[13] We also create a residualized measure of rents, based on housing characteristics. More specifically, we regress monthly rent (in logarithm) on the dwelling's quality and size, the number of floors, building material, building year, access to tap water, kitchen type, fuel type, toilet type, bathroom type, and square-footage (flexibly introduced as decile bins) as well as the rental type (public or commercial housing), and the individual's migration status, and we average the residuals by prefecture.

[14] This measure relies on the assumption that married individuals have children, and that the children are living at origin if not present in the household roster module. Another option is to use the fertility module. This module is presented to every female respondent aged 15-64; while this module allows us to

One dimension of living conditions in cities is amenities. Since amenities are largely unobservable, we estimate them based on the model (see Section 5), and assess the validity of our model-based amenity estimates using data on pollution and commuting in 2015—see Appendix A.1 for details about these additional data sources.

Table 1. Descriptive statistics (2005 1% Population Survey).

	Urban	Rural-urban migrants		
	non-migrants	All	With family	Without family
Panel A: Demographic characteristics				
Age	43.04	31.42	35.93	30.11
Female (head)	0.351	0.358	0.223	0.398
Married	0.872	0.692	0.976	0.609
Number of children	1.447	1.490	1.676	1.430
Number of children (OCP*)	1.138	1.422	1.627	1.357
Panel B: Education				
High school (at least)	0.555	0.176	0.135	0.188
College (at least)	0.246	0.020	0.011	0.022
Panel C: Economic characteristics				
Income (head, RMB)	1231	1060	1196	1023
Hours worked per week	45.84	55.49	55.26	55.55
Housing share	0.331	0.217	0.236	0.213
Panel D: Living arrangements				
Co-inhabitants	2.47	2.85	3.09	2.77
No kitchen	0.091	0.549	0.384	0.596
No toilets	0.189	0.567	0.541	0.575
House ownership	0.789	0.075	0.178	0.045
Panel E: Location characteristics				
City income (RMB)	527	829	712	863
Observations	264,794	59,183	13,327	45,856
			0.225	*0.775*

Notes: The sample is restricted to household heads aged 15–64 and living in urban areas (2005 1% Population Survey). In column 1, we report statistics for urban residents with a local *hukou*. In column 2, we report statistics for people living in urban settings but with a rural *hukou*. Columns 3 and 4 distinguish those having moved with family or not among the latter. Descriptive statistics for *Income (head, RMB)* and *Hours worked per week* are restricted to individuals who reported positive working hours in the past week; *Income (head, RMB)* is monthly income. *Number of children alive* is available for female respondents (OCP* excludes women who were above 25 when the One-Child Policy was adopted). *Housing share* is based on the predicted outcome from a regression of monthly rent (in log) for respondents renting in commercial housing on prefecture fixed effects interacted with various characteristics of the dwelling.

unambiguously determine co-residence with children, it is only available for women. The two measures, however, are highly positively correlated and yield similar results. We proceed similarly to characterize living arrangements with the China Migrants Dynamic Survey and in other Population Censuses.

2.4 Descriptive statistics

We now provide descriptive statistics about migration patterns in our context.[15] We first rely on the "2005 Mini-Census" and consider three types of urban dwellers: urban residents (with an urban *hukou* attached to their place of residence), rural-urban migrants (with a rural *hukou*) moving with family, and rural-urban migrants moving without any family. In this exercise, and in most of our baseline analysis, we define family as any parent (father, mother, father-in-law, or mother-in-law) or child, and we leave other dichotomies to Appendix A.2—together with a characterization of migration patterns from 1995 to 2010.

Table 2. Descriptive statistics (CMDS).

	Rural migrants	With family	Without family
Panel A: Expenditures			
Remittance share	0.075	0.040	0.114
Expenditure share	0.512	0.548	0.472
Non-tradables share	0.394	0.408	0.376
Panel B: Migration experience			
Age at migration	28.56	28.62	28.49
Migration across provinces	0.499	0.442	0.562
Panel C: Prospects			
Return migration	0.128	0.117	0.157
Hukou conversion	0.484	0.497	0.449
Observations	98,916	51,979	46,937
		0.525	*0.475*

Notes: The sample is restricted to household heads aged 15–64 and living in urban areas (China Migrants Dynamic Survey, CMDS). In column 1, we report statistics for people living in urban settings but with a rural *hukou.* Columns 2 and 3 distinguish those having moved with family or not among the latter. *Remittance share* is the ratio of monthly remittances to monthly income; *Expenditure share* is the ratio of monthly expenditures—excluding remittances—to monthly income; *Non-tradables share* is the ratio of consumption on food and rents to monthly income. *Migration across provinces* is a dummy equal to 1 if the last migration spell involves crossing a provincial border. *Return migration* is a dummy equal to 1 if the respondent is willing to return to their *hukou* registration place in the future. *hukou conversion* is a dummy equal to 1 if the respondent is willing to convert their *hukou* to the current destination.

We report the characteristics of these different types of urban dwellers in Table 1. Panel A shows that migrants tend to be younger than residents and have more children on average. This is partly due to the One-Child Policy, which allowed rural-*hukou* holders to have two children as against one for urban-*hukou* holders. Interestingly, migrants who live without family are quite likely to have children; these children however remain

[15]We provide additional descriptive statistics about (i) family migration over time, (ii) the geography of immigrant inflows, family migration, and remittances, (iii) the geography of migration restrictions, and (iv) the incidence of return migration in Appendix A.2.

at their location of origin (often with grandparents). Panel B shows that rural-urban migrants are much less likely to have received higher education. For instance, about 18% of migrants have at least a high school degree versus 56% of urban residents. Panel C shows that migrants earn about 15-20% less than urban residents in spite of working much longer hours per week; they however spend a (much) smaller share of their income on housing.[16] Panel D shows that migrants tend to live in larger households, even the ones moving without children. Although counterintuitive, this is related to the precarious living arrangements documented in the rest of panel D for migrants moving without family (often in dorm-like accommodation without a kitchen). Finally, panel E shows that migrants are much more likely to live in cities with high average income, and the ones that are moving without family choose destinations with a 15-20% higher average income than those who move with their family.

We complement this description with data from the China Migrants Dynamic Survey (CMDS) that we restrict to the earliest possible period (2011–2012, for which we do observe remittances and future prospects) and to rural-*hukou* holders living in urban settings. CMDS provides information about expenditures and remittances, previous and current migration experience, and future prospects. In panel A of Table 2, we report the average share of monthly income devoted to remittances, total expenditures (excluding remittances) and non-tradable consumption (food and rent). We see that migrants moving with family differ from rural-urban migrants moving without any family: the former remit less, and spend more of their income (part of it on non-tradable consumption at destination).[17] In panel B, we report the average age at migration and whether the current migration involved crossing a provincial border. Finally, panel C shows that migrants are not willing to return on average (around 13%), and a significant share are considering converting their *hukou* to the location at destination if possible (around 39%). One reason why migrants are not *all* willing to convert *hukou* is that there are advantages to holding a rural *hukou* at origin, e.g., land rights (Adamopoulos et al. 2022).

Overall, we find that migrants choose different destinations and exhibit different consumption patterns at their destination depending on the decision to migrate with or

[16]We derive housing expenditures from rents reported in the "2005 Mini-Census." One notable difference between migrants and residents is their differential access to fragmented housing markets: residents are often owning their dwelling (see Panel D) and have access to subsidized housing; rural migrants typically live in worker dormitories or under more informal rental arrangements at the fringe of cities. This is one reason for which we construct a predicted measure of rents, based on common access to commercial housing across groups.

[17]The share of migrants living with family is very different in CMDS (2011–2012, see Table 2) and in the 2005 1% Population Survey (see Table 1). This is not due to an abrupt change in migration patterns over time (see Appendix A.2), or to the selected geographic coverage of CMDS. The most likely explanation in our view is that sampling within geographic areas differs between CMDS and Censuses: CMDS arguably covers a less "floating" population than Censuses.

without their family. We further investigate these differences in the next section.

3 Motivating facts

This section establishes a few motivating facts about migrants' location choices, their living conditions, their consumption patterns, and their decision to migrate with or without their family.

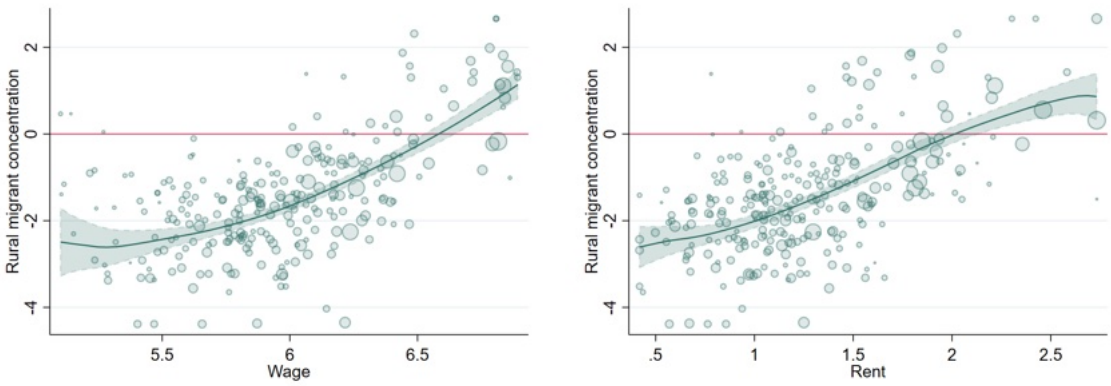
3.1 Migrant concentration

To characterize the allocation of migrants across cities, we construct m_c, a measure of migrant concentration relative to urban residents based on census data:[18]

$$m_c = \log\left(\frac{M_c/\left(\sum_c M_c\right)}{R_c/\left(\sum_c R_c\right)}\right),$$

where R_c is the initial population in city c in 2000 and M_c is the number of rural migrants arriving in city c between 2000 and 2005. This measure would be equal to 0 if the allocation of rural migrants were proportional to the resident population, or equivalently, if the immigration rate were constant across cities.

Figure 2. Rural migrant concentration, wages, and rents.



(a) Nominal wage (b) Rent

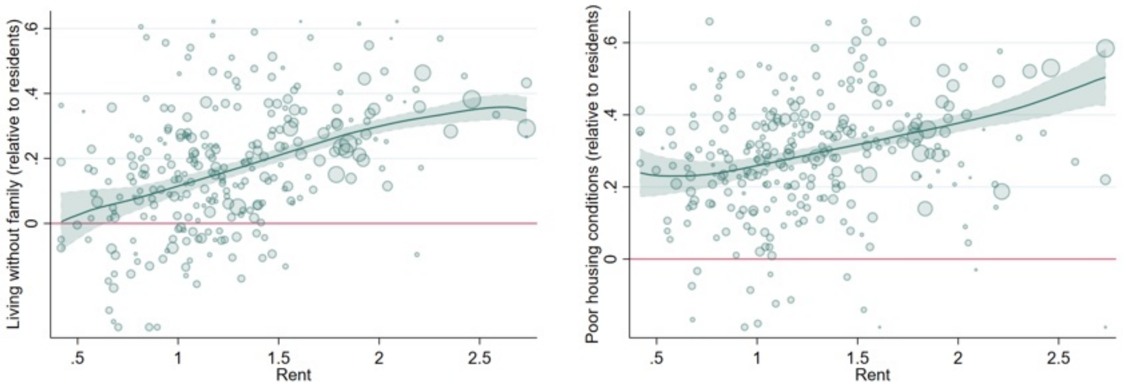
Notes: The y-axis reports the migrant concentration in city c, m_c. In panel (a), the x-axis reports a measure of (log) monthly wage; in panel (b), the x-axis reports a measure of (log) monthly rent per square meter. Wages and rents are both constructed using the 2005 Mini-Census. A bubble is a prefecture of destination and is weighted by its initial urban population in 2000. The lines are local polynomial fits, where each observation is weighted by population.

Figure 2 shows that this is not the case. Panel (a) displays the relationship between migrant concentration and a measure of (log) nominal monthly wages, w_c, in 2005. The

[18]We discuss migrant concentration using the so-called Zipf law of city size in Appendix B.2.

relationship is clearly positive: a 1% increase in the wage is associated with a 2.44% increase in rural migrant concentration. Panel (b) displays the relationship between migrant concentration and a measure of (log) monthly rents, r_c, in 2005. Again, the relationship is positive: a city with 1% higher rents exhibits a 1.96% higher rural migrant concentration.[19]

Figure 3. Migrants, family, and housing conditions.



(a) Live without family (b) Live in low-quality housing

Notes: The x-axis reports a measure of (log) monthly rents constructed using the 2005 Mini-Census. In panel (a), the y-axis reports the difference between the share of rural migrants and the share of urban residents who live without family. In panel (b), the y-axis reports the difference between the fraction of rural migrants and the fraction of urban residents who live in poor housing conditions, based on their dwelling characteristics measured in the 2005 Mini-Census. A bubble is a prefecture of destination and is weighted by its initial urban population in 2000. The lines are local polynomial fits, where each observation is weighted by population.

3.2 Living conditions in (expensive) cities

The finding that rural migrants locate in cities with high living costs may seem puzzling, since they are poorer than urban residents. We now investigate *how* rural migrants live in those expensive locations. Panel (a) of Figure 3 shows that rural migrants are about 20 percentage points more likely to live without family at their destination (i.e., without any

[19]The positive relationship between migrants and the monthly wage may be due to the fact that migrants work in destinations and sectors that require longer working hours. We provide additional evidence about these effects in Appendix B.3. Appendix Figure B.3 indeed shows that migrants are concentrated in cities where workers work more hours per month. However, even when we consider hourly wage rates, the stylized fact that migrants concentrate in high wage locations still holds. Rural migrants may also face lower mobility costs than urban residents when they move between cities, since urban residents are already settled. This could explain why there are more rural migrants relative to urban residents in high-wage locations. To test this, we use an alternative comparison group and compute the concentration of rural migrants relative to urban migrants. Appendix Figure B.5 confirms that rural migrants are disproportionately concentrated in high-wage, high-rent cities. In Appendix B.3, we also consider alternative measures of wages.

children or parents). Panel (b) shows that migrants are about 30 percentage points more likely than urban residents to live in poor quality housing, based on the characteristics of their dwelling (building material, kitchen, bathroom, and toilet type). The shares of migrants living in precarious conditions strongly increase with housing prices: While rural migrants are as likely as residents to live without family in the cheapest destinations, the difference is around 40 percentage points in the most expensive cities; similarly, rural migrants are 20 percentage points more likely to live in low-quality dwellings than residents at the cheapest destinations, and the difference rises to 50 percentage points in the most expensive ones. In summary, rural migrants choose expensive destinations and manage to reduce living costs by moving without family and living in precarious housing conditions.[20]

These differences in living standards (and arrangements) might reflect demographic differences between rural migrants and urban dwellers. In Appendix B.4, we show that rural migrants are younger and less educated than urban residents on average, and more so in high-rent cities. Rural migrants and urban residents have similar gender compositions and marriage rates on average, but rural migrants are more likely to be male and single in high-rent cities. These selection patterns do not however explain the fact that migrants are more likely to live without family. Indeed, we can identify women with children from a fertility module, and we find the same gradient: they are as likely to live with their children as the rest of the population in cheap locations, but they are 40 percentage points less likely to bring them to expensive destinations.[21]

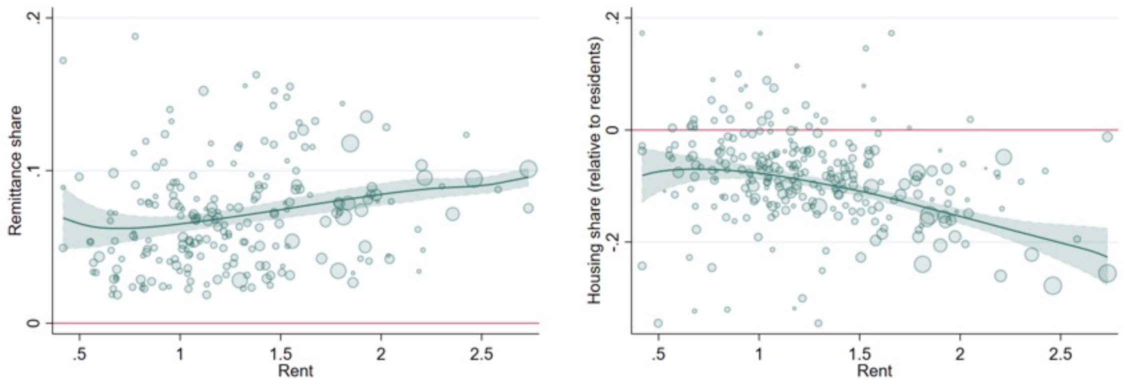
3.3 Remittances and housing expenditures

Rural migrants prioritize high-rent locations in which they need to endure difficult living arrangements. What is the economic rationale for their behavior? Figure 4 shows that rural migrants remit a substantial fraction of their income to their place of origin, especially when they live in more expensive locations: At the most expensive destinations, they remit 10% percent of their income, against 7% in the cheapest locations (panel a). In parallel, they consume a smaller share of their income on local housing, especially when

[20]We provide a sensitivity analysis in Appendix B.4, where we look at other dichotomies for living arrangements at destination, e.g., living with or without any close family members (child, spouse, or parent), with or without children, or with or without spouse. We also study how migrants sort across destinations with different *Hukou* stringency (Appendix B.7), we characterize the dynamics of migration arrangements across cities (Appendix B.6), and we document migrants' intentions and preferences for return migration in Appendix B.8.

[21]The stylized facts reflected in Figures 2 and 3 may be sensitive to our definition of migration. This measure is based on the discrepancy between an individual's place of residence and place of household registration, and thus misses rural migrants who have obtained a local urban *Hukou* at destination. In Appendix B.9, we develop alternative definitions based on the 2000 Census and 2005 Mini-Census to show the robustness of the stylized facts to the definition of migration.

Figure 4. Migrants, remittances, and housing expenditures.



(a) Remittances

(b) Housing share

Notes: The x-axis reports a measure of (log) monthly rents constructed using the 2005 Mini-Census. In panel (a), the y-axis reports a measure of remittances as a share of income, extracted from CMDS 2011–2012. In panel (b), the y-axis reports the difference between housing expenditures as a share of income for rural migrants and for urban residents, where housing expenditure shares are based on the predicted outcomes from regressions of monthly rent (in log) for respondents renting in commercial housing on prefecture fixed effects interacted with various characteristics of the dwelling. A bubble is a prefecture of destination and is weighted by its initial urban population in 2000. The lines are local polynomial fits, where each observation is weighted by population.

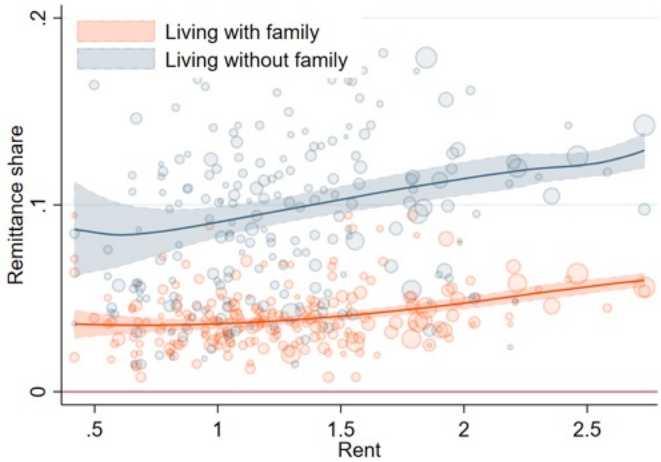
living in expensive locations—the difference in the housing expenditure share relative to natives is then close to 20 percentage points (panel b). In effect, migrants transfer part of their consumption back to their place of origin.

Figure 5 further investigates the consumption patterns of migrants, looking separately at those who live with and without family. Rural workers who migrate without family remit a higher fraction of their income (about 10% versus 4% for those living with their family); we show in Appendix B.5 that they consume a smaller share of their income on local non-tradables, as compared to migrants living with family.[22] Migration and consumption patterns are tightly linked: migrants choose between two different ways of living at their destination; they either migrate with their family and consume locally or migrate on their own and partly consume at origin.

These stylized facts explain why rural migrants in China are described as a "floating population." They choose high-wage destinations to maximize their nominal income, and they cope with the high living costs by not bringing their family and by reducing their consumption of local housing, so that they are ultimately able to remit more to their place of origin. In the next section, we develop a spatial equilibrium model of migration

[22]While the difference in housing expenditure share does not mirror exactly the difference in remittances (about 2.9 percentage points for housing versus 7.5 percentage points for remittances), we find more comparable magnitudes when looking at total consumption on non-durables at destination (see Table 2). We discuss this additional evidence in Appendix B.5.

Figure 5. Migrants living with (orange) and without family (blue), and remittances.



Notes: The x-axis reports a measure of (log) monthly rents constructed using the 2005 Mini-Census. IThe y-axis reports a measure of remittances as a share of income as extracted from CMDS 2011–2012. The orange (resp. blue) lines and bubbles are computed from the subsample of migrants living with (resp. without) family at destination. A bubble is a prefecture of destination and is weighted by its initial urban population in 2000. The lines are local polynomial fits, where each observation is weighted by population.

decisions that allows migrants to consume part of their income at origin and to choose between migrating with or without their family.

4 Model

In this section, we introduce a quantitative, spatial model of location choice where households might enjoy the consumption of the non-tradable good across two locations: their destination and their place of origin. The model relies on assumptions designed to capture the specific context of China before and after the liberalization of migration, although it can be generalized to other contexts with migration frictions. For simplicity, we assume that the initial population in each location, both rural and urban, is fixed, and we denote the initial population distribution with subscript 0. We further assume that agents are equally productive and that urban residents do not move; only rural households are allowed to relocate.[23]

4.1 Preferences

We assume that the utility of household i born and *staying* in location r is given by,

$$\ln U_{ir} = \ln C_r + \ln \varepsilon_{ir},$$

[23]We explore how to relax the assumption that urban residents are immobile in Appendix C.1, and we extend the model to multiple labor types in Appendix C.2.

where C_r is a composite consumption index, and ε_{ir} is an idiosyncratic taste parameter for location r; we will denote as R the set of rural locations and as U the set of urban locations. We assume that C_r is a Cobb-Douglas composite index aggregating the consumptions of the tradable good and the non-tradable good as follows,

$$C_r = C_{T,r}^{1-\alpha} C_{NT,r}^{\alpha}.$$

Finally, household i faces a budget constraint,

$$C_{T,r} + p_r C_{NT,r} \leq w_r.$$

The same household i might also *migrate* to urban destination u, in which case her utility would be given by,

$$\ln U_{ijru} = -\tau_{jru} + \ln C_u + \ln \varepsilon_{ijru},$$

where: the subscript $j \in \{1, 2\}$ denotes whether the household decides to leave the family in the rural location ($j = 1$) or not ($j = 2$); τ_{jru}, the bilateral cost induced by a migration spell from origin r to destination u, is allowed to differ by migration mode; ε_{ijru} is an idiosyncratic taste parameter for location u and migration mode j; and C_u, the consumption composite index, now aggregates the consumptions of the tradable good and the non-tradable good *across locations* as follows,

$$\ln C_u = (1-\alpha) \ln C_{T,u} + \alpha \ln \left[\alpha_{jD}^{\frac{1}{\rho}} C_{H,u}^{\frac{\rho-1}{\rho}} + \alpha_{jO}^{\frac{1}{\rho}} C_{R,u}^{\frac{\rho-1}{\rho}} \right]^{\frac{\rho}{\rho-1}},$$

where $C_{H,u}$ represents non-tradable goods that are consumed at destination, $C_{R,u}$ represents non-tradables consumed at origin, via remittances, ρ is the elasticity of substitution between consuming at origin and at destination, and $\alpha_{jD} + \alpha_{jO} = 1$ are the relative weights allocated to these respective consumptions. The migrant household i faces a budget constraint,

$$C_{T,u} + p_u C_{H,u} + p_r C_{R,u} \leq w_u.$$

The indirect utility of a migrant household will thus differ from stayers in four ways: (i) a migrant household faces different returns to labor and prices of the non-tradable good (w, p); (ii) a migrant household enjoys different amenities; (iii) households pay migration bilateral costs; and (iv), more importantly, migrant households consume a different bundle of the non-tradable good. For instance, we will typically consider that $\alpha_{1D} < \alpha_{2D} \leq 1$ to capture the fact that leaving family behind allows migrants to consume more of the non-tradable good at origin and a higher share of income needs to be sent back home (in the form of remittances). Note that we allow α_{2D} to differ from 1 (or reciprocally, α_{2O} to be positive) in order to capture, for example, the remittances sent to indirect family or investment at origin, e.g., the construction of a family home for an eventual return to the village. It is worth noting that our model abstracts from intra-household bargaining or other forms of collective decision making: the model is one of a unitary household.

Household utility maximization results in the following expenditure functions:

$$\ln\left(\frac{C_{T,u}}{w}\right) = \ln(1-\alpha)$$
$$\ln\left(\frac{p_u C_{H,u}}{w}\right) = \ln\alpha + \ln\alpha_{jD} - (\rho-1)\ln\left(\frac{p_u}{\mathcal{P}_{jru}}\right)$$
$$\ln\left(\frac{p_r C_{R,u}}{w}\right) = \ln\alpha + \ln\alpha_{jO} - (\rho-1)\ln\left(\frac{p_r}{\mathcal{P}_{jru}}\right)$$

where:

$$\mathcal{P}_{jru} = \left(\alpha_{jO} p_r^{1-\rho} + \alpha_{jD} p_u^{1-\rho}\right)^{\frac{1}{1-\rho}}$$

is a migrant-specific composite price index of the non-tradable good. These equations already capture some of the previous stylized facts discussed in Section 3: (i) the remittance share is higher in expensive locations; and (ii) households who migrate without family remit a higher share of their income, or conversely, those who migrate with the family devote a higher share of their income to non-tradable services at destination.

We use these expenditure functions to compute the indirect utility of a migrant household i from origin $r \in R$ and j-moving to destination $u \in U$:

$$\ln V_{jru} - \tau_{jru} + \varepsilon_{ijru} = \ln w_u - \alpha \ln \mathcal{P}_{jru} - \tau_{jru} + \varepsilon_{ijru}$$

and the indirect utility of staying in the rural location:

$$\ln V_{rr} + \varepsilon_{ijrr} = \ln w_r - \alpha \ln p_r + \varepsilon_{ijrr}.$$

A crucial insight is that indirect utilities for rural-urban migrants are driven by wages at destination deflated by a composite price index that is specific to the migration mode and combines the prices of non-tradable goods at destination *and* at origin.

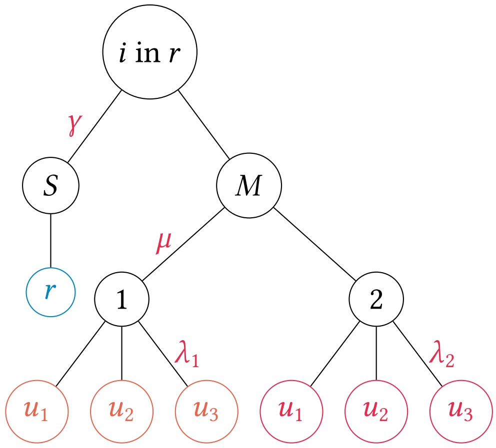
4.2 Location choice

The indirect utility representation allows us to formulate a discrete, nested choice model capturing whether, how, and where households relocate. The program is given by:

$$\max_{\mathbf{k}} \{\ln V_{\mathbf{k}} - \tau_{\mathbf{k}} + \varepsilon_{\mathbf{k}}\},$$

where $\mathbf{k}$ is a vector capturing whether, how (j), and where (u) to relocate. We assume that idiosyncratic preferences for relocation, $\varepsilon_{\mathbf{k}}$, are drawn from a generalized extreme value distribution with a nested structure. We suppose that the three nests are organized

Figure 6. The nested logit structure.



Notes: The Figure represents the nested structure induced by our assumptions on the distribution of idiosyncratic preferences for relocation, $\varepsilon_{\mathbf{k}}$. The parameter γ is the shape parameter for the upper nest of the generalized extreme value distribution; the parameter μ is the shape parameter for the intermediate nest of the generalized extreme value distribution; and the parameters (λ_1, λ_2) are the shape parameters for the lower nests of the generalized extreme value distribution.

as follows (see Figure 6 for a graphical representation): the upper nest of the generalized extreme value distribution is about whether the household relocates, and the associated shape parameter is γ; the intermediate nest is about choosing $j \in \{1, 2\}$, and the associated shape parameter is μ; and the lower nests are about location choices with shape parameters (λ_1, λ_2). Given this structure, the probability that household i j-relocates from r to u is given by:

$$\pi_{jru} = \frac{M_{jru}}{N_{r,0}} = \left(\frac{V_{U,r}}{V_r}\right)^{1/\gamma} \left(\frac{V_{jU,r}}{V_{U,r}}\right)^{1/\mu} \left(\exp\left(-\tau_{jru}\right) \frac{V_{jru}}{V_{jU,r}}\right)^{1/\lambda_j} \tag{1}$$

The flow of migrants who migrate with or without family, and from r to u, can be decomposed into three terms. The first term, $\left(V_{U,r}/V_r\right)^{1/\gamma}$, captures the share of households who are born in r and relocate elsewhere. The second term, $\left(V_{jU,r}/V_{U,r}\right)^{1/\mu}$, captures the fraction of households that migrate with living arrangement j among those who migrate. The third term, $\left(\exp\left(-\tau_{jru}\right) V_{jru}/V_{jU,r}\right)^{1/\lambda_j}$, captures the fraction of those movers that choose destination u. The parameters γ, μ, and (λ_1, λ_2) govern the elasticities of substitution between moving or staying in the original location, migrating with the family or not, and between choosing alternative destinations (which we allow to differ by migration mode, j). The expected value of being born in r, V_r, is given by:

$$V_r = \left[V_{rr}^{1/\gamma} + V_{U,r}^{1/\gamma}\right]^{\gamma}.$$

The expected value of relocating from r is:

$$V_{U,r} = \left[\sum_{j\in\{1,2\}} \left(V_{jU,r}\right)^{1/\mu}\right]^{\mu}.$$

The expected value of relocating from r with ($j = 1$) or without ($j = 2$) family is:

$$V_{jU,r} = \left[\sum_{u \in U} \left(\exp\left(-\tau_{jru}\right) V_{jru} \right)^{1/\lambda_j} \right]^{\lambda_j}.$$

4.3 Local labor markets

We now turn to the production of the tradable and non-tradable goods. We assume that the tradable good in location u is produced with the following production function:

$$Y_u = A_u \left[(1-\beta) K_u^{\frac{\sigma-1}{\sigma}} + \beta L_u^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}},$$

where A_u is the local (exogenous) productivity, K_u denotes capital or land, and L_u denotes the amount of workers in u. The parameter σ denotes the elasticity of substitution between labor and the other factor. The parameter β is the weight of labor in production.

Profit maximization leads to the following (inverse) labor demand equation:

$$\ln w_u = \ln A_u + \ln \beta - \frac{1}{\sigma} \ln L_u + \frac{1}{\sigma} \ln Y_u. \tag{2}$$

4.4 Local housing markets

Non-tradable output, or, in short, housing services, is produced by combining the tradable good and land—in fixed supply—according to the following production function:

$$Y_u^H = \nu_u^{-\nu_u} \left(Y\right)^{\nu_u} \left(T_u^H\right)^{1-\nu_u},$$

where $1 - \nu_u$ is the importance of land as an input in location u. In places where land is an important input, the supply of housing is more costly to adjust.

Profit maximization leads to the following housing supply equation:

$$Y_u^H = T_u^H \left(p_u\right)^{\eta_u}$$

where $\eta_u = \frac{\nu_u}{1-\nu_u}$ is the housing supply elasticity. Lower values of η_u indicate that housing supply is less responsive to the housing price, p_u.

4.5 Equilibrium

The market equilibrium for the tradable good is given by:

$$\tilde{\beta} Y = \tilde{\beta} \sum_u Y_u = \sum_u w_u L_u + \sum_r w_r L_r, \tag{3}$$

where $\tilde{\beta}$ is the share of income that goes to labor, which, in principle, is endogenous and depends on the elasticity of substitution between labor and other factors. In practice, this share is close to the parameter β, the weight of labor in production.

The market for the non-tradable good clears in each location:

$$T_u^H (p_u)^{\eta_u} = \frac{w_u}{p_u} \left[\alpha N_u + \Lambda_u M_u \right]$$

where $\Lambda_u M_u = \sum_r \Lambda_{r,u} M_{r,u}$, the Λ's denote the (endogenous) shares of expenditure spent on housing, and $M_{r,u}$ is the number of households moving from location r. The previous expression equates housing supply and demand. It is worth noting that the demand for housing in a location depends on the demand for housing of urban residents (N_u) and on the demand for housing of migrants (M_{ru}), who spend a smaller fraction of their income on housing.

We combine the market clearing condition with the (inverse) labor demand equation to obtain:

$$\ln p_u = \frac{1}{1+\eta_u} (\ln A_u + \beta \ln Y_u) + \frac{1-\frac{1}{\sigma}}{1+\eta_u} \ln \alpha N_u + \frac{1}{1+\eta_u} \left(\Lambda - \frac{1}{\sigma} \right) \frac{M_u}{N_u} - \frac{1}{1+\eta_u} \ln T_u^H, \quad (4)$$

where we assumed that the population of migrants is small relative to overall city population (thus considering the following approximation, $\ln(1+x) \approx x$).

Equation 4 shows that local housing prices depend on local productivity, the size of the location, the availability of land, and the relative size of the migrant population—measured as the ratio of migrants to urban residents. Whether migrants have a large, positive or negative effect on housing prices depends on three parameters: Λ, ρ, and η_u. It is worth noting that whether immigrants exert pressure or relax pressure on housing markets depends on whether the fraction of income spent locally is larger or smaller than the pressure immigrants exert on labor markets (governed by the inverse elasticity of substitution between labor and the other factors).[24] Moreover, irrespective of whether immigrants lead to an increase or a decline in house prices, the effect of migration on housing markets is attenuated by the housing supply elasticity. Intuitively, if it is easy to expand the supply of housing, then η_u is larger and, hence, tends to mitigate any effect that immigrants may have on local housing prices.

5 Estimation

In this section, we estimate the main parameters of the model: (a) the elasticity of substitution between consuming at origin and at destination, and the share of income spent on

[24] To give some intuition, if the local production function is Cobb-Douglas and $\rho = 1$, then the market clearing for housing implies that:

$$\ln p_u = \frac{1}{1+\eta_u} \ln A_u + \frac{1-\beta}{1+\eta_u} \ln K_u + \frac{1}{1+\eta_u} (\alpha_D - \beta) \frac{M_u}{N_u} - \frac{1}{1+\eta_u} \ln T_u^H.$$

In this case, whether immigrants have a positive or negative effect on housing prices depends on whether the share of income that immigrants devote to housing is higher than the share of income in production that goes to labor.

non-tradable goods; (b) the shape parameters of the location choice model—the migration elasticities with respect to conditions at destination, to the mode of migration, and to conditions at origin; and (c) the two elasticities that govern the response of wages and rents to migrant inflows at destination (the labor demand and housing supply elasticities). The estimation relies on various sources of exogenous variation that we introduce here and describe in greater detail in Appendix D.

5.1 A composite price index

This section identifies the elasticity of substitution between consuming the non-tradable good across locations and the respective income shares, which allow us to construct the composite price index, $\mathcal{P}_{jru}$, across migration spells and the modes of such spells. It is worth noting that this elasticity of substitution could, in principle, depend on migration mode. As we will see, however, the estimates encourage us to assume a single ρ.

We use the expenditure function obtained from the utility maximization problem to derive an empirical relationship between the average (log) expenditure share on remittances in city u, $\ln(\mathcal{E}_u)$, and local housing prices, p_u, both constructed from the "2005 Mini-Census":

$$\ln(\mathcal{E}_u) = \ln\alpha + \ln\alpha_O + (\rho - 1)\ln p_u + e_u,$$

where the residual, e_u, contains part of the price index, $\mathcal{P}$, that is specific to migrants across different migration spells (origins and with/without family). This induces an endogeneity concern with omitted variation jointly affecting prices and expenditure shares.

We identify the elasticity ρ by exploiting the exogenous variation in housing prices (p_u) induced by local geography around city borders in the baseline period (an instrument based on the work by Saiz 2010, Harari 2020, see Appendix D.1). The estimates of ρ are reported in Table 3, using the sample of migrants leaving their family at origin in column (1) and migrants living with family at destination in column (2). Our estimates are consistent with an average elasticity $\rho - 1 \approx 0.71$ across the two migration modes.[25] There is some substitution between consuming at destination or at origin, and high housing prices induce migrants to displace more of their consumption to rural hinterlands—which is consistent with our findings about living conditions in expensive cities (see Section 3).

Data on housing prices across locations (p_u, p_r) and the estimation of $(\rho, \alpha, \alpha_{1O}, \alpha_{2O})$ allow us to compute the actual price indices $\mathcal{P}_{jru}$ faced by migrants and the migrant-

[25] All our regressions use the largest connected set of prefectures, i.e., the group of prefectures connected by labor mobility in the "2005 Mini-Census" data. This restriction is necessary for fixed effects to be comparable when we decompose migration costs in Section 5.4 (see, e.g., Abowd et al. 1999, Card et al. 2013, Buggle et al. 2022) and thus applied throughout for consistency.

Table 3. Estimates of ρ.

Remittance share (log)	(1)	(2)
Rent (log)	0.850	0.577
	(0.291)	(0.212)
Observations	199	199
Migration mode	$j = 1$	$j = 2$
F-stat	8.48	8.48

Notes: A unit of observation is a prefecture. Robust standard errors are reported between parentheses. The specification uses population weights in 2000. The dependent variable is the (log) expenditure share spent on remittances (CMDS, 2011) and the explaining variable is the (log) rent, computed using the housing module of the "2005 Mini-Census." In column (1), the expenditure share on remittances is calculated for migrants leaving their family at origin ($j = 1$); and the expenditure share on remittances is calculated for migrants bringing their family at destination in column (2) ($j = 2$). The (log) rent is instrumented by (i) the share of developable land as induced by local geography around city borders in the baseline period (2000-2005), an instrument based on the work by (Saiz 2010, Harari 2020, Appendix D.1), and (ii) its interaction with manufacturing Total Factor Productivity in 2000 (Imbert et al. 2022). The set of controls consists of: manufacturing Total Factor Productivity in 2000, the share of developable land as induced by local geography around city borders before the baseline period (1995-2000), and (log) population in 2000.

specific real wages across destinations. We use these real wages to estimate the location choice model.

5.2 Estimation of the location choice model

The location choice model is characterized by three nests and their associated parameters: the lower nest and the associated elasticity of substitution across destinations (λ_1, λ_2); the middle nest, governing how migrants move to cities (μ) ; and the upper nest, disciplining emigration flows across origins (γ). We estimate these nests sequentially.

The lower nest (λ_1, λ_2) We can write Equation (1) as follows:

$$\ln \pi^c_{jru} = -\frac{1}{\lambda_j}\tau_{jru} + \delta_{jr} + \frac{1}{\lambda_j}\left[\ln w_u - \alpha \ln \mathcal{P}_{jru}\right], \qquad (5)$$

where r is a prefecture of origin, u is a prefecture of destination, and j is the mode of the migration spell (with or without family); and π^c_{jru} is the probability to migrate to u conditional on j-migrating from r. This gravity model has three components: (i) migration costs such as land (in)security at origin, distance, or information barriers (see for instance Young 2013, Gollin et al. 2014, Bryan and Morten 2019, Brandt et al. 2013, Tombe and Zhu 2019, Gai et al. 2021, Adamopoulos et al. 2022); (ii) conditions at origin that we capture with origin/mode fixed effects, δ_{jr}; and (iii) real wages at destination.

The identification of (λ_1, λ_2) is challenging: real wages are affected by migration (a reverse causality that we quantify in Section 5.3); and unobserved destination characteristics, e.g., local amenities, might affect both real wages and immigration flows (omitted variation). We use intrinsic productivity and industrial differences across locations as an exogenous shifter for the level of real wages. More specifically, we construct migration rates between 2000 and 2005 as a proxy for π_{jru}, we use data from the "2005 Mini-Census" and our previous estimates to construct real wages in 2005, and we instrument the latter with manufacturing Total Factor Productivity in 2000 (Imbert et al. 2022) and a trade shock computed following Facchini et al. (2019).[26]

Table 4. The lower nest (λ_1, λ_2).

Migration rate	(1)	(2)	(3)	(4)
Value at destination ($\ln V_{jru}$)	3.928	5.350	2.498	3.008
	(0.376)	(0.632)	(0.224)	(0.510)
Observations	48,084	48,084	47,728	47,728
Migration mode	$j = 1$	$j = 1$	$j = 2$	$j = 2$
Instruments	No	Yes	No	Yes
F-stat	-	25.13		24.31

Notes: A unit of observation is a pair of origin/destination prefectures in 2005. The specification uses population weights at origin in 2000. The estimation is a Poisson regression in columns (1) and (3) and a two-stage Poisson regression in columns (2) and (4). Standard errors are reported between parentheses and clustered at the level of origins. The dependent variable is the (log) emigration rate between 2000 and 2005, computed using the migration module of the "2005 Mini-Census." In columns (1) and (2), the emigration rate is calculated for migrants leaving their family at origin ($j = 1$); the emigration rate is calculated for migrants bringing their family at destination in columns (3) and (4) ($j = 2$). The set of controls consists of: (log) population at destination in 2000 and (log) geodesic distance between the origin and destination prefectures. In columns (2) and (4), the (log) real wage is instrumented by manufacturing Total Factor Productivity at destination in 2000 (Imbert et al. 2022) and a trade shock computed following Facchini et al. (2019)—see Appendix D.2.

We present the estimates of λ_1 in columns (1) and (2) of Table 4 and the estimates of λ_2 in columns (3) and (4). Our estimates suggest that a real wage increase of 1% would increase immigration by 5.4% among non-family migrants and by 3% among family migrants. The elasticity of substitution across alternative destinations is larger among migrants who leave family behind, possibly capturing the fact that they care little for other aspects of living standards at destination.

The middle nest (μ) The novelty of our location choice model is to consider the decision of moving with or without family, with implications about the relative sensitivity

[26] We provide a discussion of the identification strategy and robustness checks in Appendix D.2.

to conditions at destination. The middle nest of the location choice model implies that the relative incidence of family emigration verifies:

$$\ln\left(\frac{\pi^c_{2r}}{\pi^c_{1r}}\right) = \frac{1}{\mu}\ln\left(\frac{V_{2U,r}}{V_{1U,r}}\right),$$

where $\pi^c_{jr} = \sum_u \pi^c_{jru}$ is the emigration rate of migrants of mode j from origin r, conditional on emigrating from r.

The identification of the shape parameter μ is not straightforward. First, the relative value of migrating with and without family is not observed but needs to be constructed based on the estimates from the lower nest.[27] Second, they may be contaminated by measurement error or omitted variation across origin-destination pairs that could affect differently migration modes. For instance, migrant networks might be more prevalent for single migrants. We address this identification concern by leveraging the (gravity) structure of our model. The relative value of family migration across origins r can be written as:

$$\ln\left(\frac{V_{2U,r}}{V_{1U,r}}\right) = \ln\left(\frac{\left[\sum_{u\in U}\left(\exp\left(-\tau_{2ru}\right)V_{2ru}\right)^{1/\lambda_2}\right]^{\lambda_2}}{\left[\sum_{u\in U}\left(\exp\left(-\tau_{1ru}\right)V_{1ru}\right)^{1/\lambda_1}\right]^{\lambda_1}}\right),$$

where bilateral migration costs (τ_{jru}), which are increasing in distance between origin and destination, interact with the relative attractiveness of destinations for families (V_{jru}).

We consider two sources of exogenous variation that impact the relative value of family migration from a given origin. The first source of exogenous variation hinges on the fact that migrants with family differentially respond to prices at possible destinations, and that we do observe exogenous variation in those prices. More specifically, we create a measure of predicted wage in cities by regressing observed wages on manufacturing Total Factor Productivity at destination in 2000 (Imbert et al. 2022) and a trade shock computed following Facchini et al. (2019); we create a measure of predicted rent in cities based on the share of developable land as induced by local geography around city borders; and we combine these two prices to extract a measure of real wages, $\hat{\omega}_{ju}$, per mode j—accounting for their differential consumption of non-tradables at destination. Our first instrument is then:

$$z^1_r = \ln\frac{\sum_{u\in U}\hat{\omega}_{2u}/d_{ru}}{\sum_{u\in U}\hat{\omega}_{1u}/d_{ru}},$$

which is a gravity-weighted combination of relative real wages, as induced by exogenous variation in prices across destinations and distance to those possible destinations, d_{ru}.

The second source of variation exploits instead exogenous variation in non-monetary barriers to family migration across destinations (see Appendix D.2 for a more exhaustive discussion of identification). Intuitively, some origins are closer to cities where family

[27] We detail this procedure in Appendix D.2.

migration is discouraged, while other origins are closer to family-friendly cities. One component of such attractiveness is *hukou* stringency. However, *hukou* restrictions are not exogenous to migration flows, and there is clear reverse causation. We thus substitute *hukou* stringency with a historical, more exogenous predictor of restrictions: the relative level of grain reserves before 2000, g_u, across potential destinations, as in Zhang et al. (2020). Local self-sufficiency in grain was indeed a major tenet of Mao Zedong's conception of development, from the Great Leap Forward (1958–1960) to the Cultural Revolution (1966–1976), partly owing to the severe constraints on the non-market allocation of resources in a poor country with limited communications and state capability (see, e.g., Riskin 1981). As food provision became completely separated from household registration only in 2000, cities therefore had to maintain the agricultural capacity to nourish their population, including migrants (Cai et al. 2001).[28] We combine this variation g_u with the (baseline) emigration patterns from an origin r to possible destinations u, ξ_{ru}, in a gravity structure mimicking the previous equation to construct an instrument z_r^2 for the relative value of family migration:

$$z_r^2 = \sum_{u \in U} \xi_{ru} g_u.$$

We present the estimates of μ in Table 5 and show that a 10% increase in the relative value of moving with the family raises the incidence of family migration by about 50%—which translates into estimates of μ around 0.20.

The upper nest (γ) We use the previous parameters to construct the relative value of migrating across origins r and relate it to the relative incidence of emigration:

$$\ln\left(\frac{1-\pi_{rr}}{\pi_{rr}}\right) = \frac{1}{\gamma} \ln\left(\frac{V_{U,r}}{V_{rr}}\right).$$

In the previous equation, the value $V_{U,r}$ is a complicated object, which we construct based on lower and middle-nest estimates, and is likely affected by various sources of measurement error and omitted variation.[29] By contrast, the value of staying V_{rr} has a simple representation in terms of (log) real wages at origin, $\ln w_r - \alpha \ln p_r$. We exploit the disparities in real wages across origins and isolate exogenous variation by combining local cropping patterns with innovations in the price of agricultural commodities: origins with highly demanded agricultural products in the early 2000s will retain a higher fraction of their population between 2000 and 2005 (as documented in Imbert et al. 2022).

[28] This policy implied huge costs from misalignment with local comparative advantage, but the memory of the Great Famine (and its handling by the Central Government, see Meng et al. 2015) may have convinced local decision-makers that relying on outside supplies of grain was risky.

[29] See Appendix D.2 for more details about the construction of this value function.

Table 5. The middle nest (μ).

Family migration	(1)	(2)	(3)	(4)
Relative value	0.832	5.273	3.921	4.947
	(0.238)	(1.545)	(1.437)	(1.231)
Observations	177	177	177	177
Instrument(s)	-	z_r^1	z_r^2	z_r^1, z_r^2
F-stat	-	12.70	9.23	11.25

Notes: A unit of observation is a prefecture. Robust standard errors are reported between parentheses. The specification uses population weights in 2000. The dependent variable is the relative incidence of family emigration between 2000 and 2005, computed using the migration module of the "2005 Mini-Census." The explanatory variable is the model-computed relative value of family migration from each origin. The set of controls consists of: dummies for each quintile in the level of grain reserves within the prefecture before 2000, the manufacturing Total Factor Productivity at origin in 2000 (Imbert et al. 2022), a trade shock computed following Facchini et al. (2019), a local price shock as induced by international crop prices (Imbert et al. 2022), and the share of developable land as induced by local geography around city borders before the baseline period (1995-2000). The instruments are gravity-based measures combining predicted real wages from TFP and from trade and land supply shocks, $\hat{\omega}_{ju}$ (per mode j), and the relative level of grain reserves before 2000, g_u, across potential destinations—see Appendix D.2. In column (2), the instrument is z_r^1; in column (3), the instrument is $z_r^2 = \sum_{u \in U} \xi_{ru} g_u$; and we include both instruments, z_r^1 and z_r^2, in column (4).

Table 6. The upper nest (γ).

Emigration	(1)	(2)	(3)
Relative value of emigration	1.269	2.037	2.249
	(0.112)	(0.321)	(0.465)
Observations	258	258	187
Additional controls	No	No	Yes
Instrument	No	Yes	Yes
F-stat	-	31.56	19.08

Notes: A unit of observation is a prefecture. Robust standard errors are reported between parentheses. The specification uses population weights at origin in 2000. The dependent variable is the relative incidence of emigration between 2000 and 2005, computed using the migration module of the "2005 Mini-Census." The set of additional controls consists of: dummies for each quantile in the level of grain reserves within the prefecture before 2000, the manufacturing Total Factor Productivity at destination in 2000 (Imbert et al. 2022), a trade shock computed following Facchini et al. (2019), and the share of developable land as induced by local geography around city borders. The instrument interacts cropping patterns in 2000 with the HP-filtered prices of agricultural commodities in 2000 (as in Imbert et al. 2022, see also Appendix D.2).

We present the estimates of the upper nest in Table 6, which correspond to an elasticity of substitution between staying and migrating of about 2. Places that received positive income shocks retain a (much) larger fraction of their population.

5.3 Labor demand and housing supply at destination

The last block of the model is the production at destination: the (inverse) labor demand elasticity disciplines the response of wages to new arrivals, while the housing supply elasticity disciplines the response of the housing price. To estimate the former, we use Equation 2 and derive an empirical counterpart as follows. We consider the equation in difference between 2000 and 2005 in order to clean for unobserved, fixed heterogeneity across destinations indexed by u:

$$\Delta \ln w_u = -\frac{1}{\sigma} m_u + \mathbf{X_u} \delta + \varepsilon_u, \tag{6}$$

where $\Delta \ln w_u$ is the change in (log) wages between 2000 and 2005, $m_u = \ln(1 + M_u/N_u)$ is the immigrant-driven population change during the period, and $\mathbf{X_u}$ is a vector of controls. To identify the elasticity of substitution between labor and other factors, we exploit an agriculture-based shock that pushes migrants at the typical origin of destination u (in a shift-share design, closely following Imbert et al. 2022, see also Appendix D.2). As the nature of the push shock relates to rural cropping patterns and the price of agricultural commodities, the identification relies on the assumption that crop production only affects urban production through rural-urban migration.

Table 7. Labor demand and housing supply elasticities.

	Wage			Rent		
	(1)	(2)	(3)	(4)	(5)	(6)
Immigration rate	-0.131	-0.128	-0.198	0.084	0.454	0.163
	(0.055)	(0.061)	(0.164)	(0.078)	(0.123)	(0.564)
Observations	216	216	216	252	252	252
Controls	No	Yes	Yes	No	Yes	Yes
Instrument	No	No	Yes	No	No	Yes
F-stat	-	-	27.31	-	-	24.88

Notes: A unit of observation is a prefecture. Robust standard errors are reported between parentheses. The specification uses population weights at origin in 2000. The explanatory variable is the relative immigration rate between 2000 and 2005, computed using the migration module of the "2005 Mini-Census." The set of baseline controls consists of: (log) population in 2000 and agricultural shocks at the typical origin associated with the prefecture before the period of interest (1995-2000). We add the following controls in columns (1) to (3): the manufacturing Total Factor Productivity at destination in 2000 (Imbert et al. 2022), and a trade shock computed following Facchini et al. (2019). We add the following controls in columns (4) to (6): the (log) migrant population in 2000, the share of developable land as induced by local geography around city borders before the baseline period (an instrument based on the work by Saiz 2010, Harari 2020, see Appendix D.1), and their interaction. The instrument exploits agricultural shocks between 2000–2005 at the typical origin associated with the prefecture (as in Imbert et al. 2022, see also Appendix D.2).

A similar approach can be used to estimate the elasticity of housing supply. We difference out Equation (4) between 2000 and 2005 to obtain:

$$\Delta \ln p_u = \frac{1}{1+\eta_u}\left(\Lambda - \frac{1}{\sigma}\right) m_u + \mathbf{X_u}\delta + \varepsilon_u, \tag{7}$$

where $\Delta \ln p_u$ is the change in (log) rents between 2000 and 2005 and m_u is instrumented with the previous shift-share instrument.

We report our preferred estimates for the labor demand and housing supply elasticities in Table 7—respectively in columns (1) to (3) and columns (4) to (6). In general, one would expect migrants to sort into high-wage destinations and the OLS would be biased upward. In practice, we find similar elasticities using the OLS or IV specifications, albeit imprecisely estimated. The labor demand elasticity is close to the one reported in Imbert et al. (2022), $1/\sigma \approx 0.2$. The housing supply elasticity can be computed from $\left(\Lambda - \frac{1}{\sigma}\right) / (1+\eta_u) = 0.163$, which implies $\eta_u = 2.4$.

Table 8. Migration costs and migration policies.

Bilateral migration costs	(1)	(2)	(3)	(4)
Hukou conversion	-6.164	-9.294		
	(2.338)	(2.977)		
Hukou stringency (index)			2.228	3.213
			(1.175)	(1.558)
Observations	3,113	1,613	2,471	1,303
Migration mode	$j=1$	$j=2$	$j=1$	$j=2$
F-stat	9.83	9.90	8.96	14.14

Notes: A unit of observation is a destination/origin pair within the connected set. Standard errors are clustered at the level of destinations and are reported between parentheses. The specification uses population weights in 2000. The dependent variable is the model-computed bilateral cost of migration, τ_{jru}. *Hukou conversion* is the share of migrants who had converted their *hukou* registration place to the local prefecture in 2010, as observed from the 2010 Census. *Hukou stringency (index)* is the composite *hukou* stringency index developed by Zhang et al. (2018). The set of controls consists of: dummies for each quintile in the level of grain reserves within the prefecture of origin before 2000, a local price shock between 1995–2000 and 2000–2005 as induced by international crop prices (Imbert et al. 2022), and bilateral distance between origin and destination. The instrument is the relative level of grain reserves before 2000, g_u—see Appendix D.2.

5.4 A decomposition of migration costs

Before turning to counterfactual experiments, we need to better characterize the nature of migration frictions—the τ_{jru} of the model that allow us to match migration flows (see Appendix D.4)—and how they relate to actual migration policies, versus other economic, physical, or cultural factors.[30]

[30] In Appendix D.4, we provide additional evidence about the relationship between our estimated migration frictions across migration patterns (with or without family) and observable characteristics, e.g.,

Migration policies are influenced by various factors that are imperfectly observed and might directly enter the choice of potential migrants (e.g., the tightness of local labor markets, the quality of local public goods, or the state of local finances). We exploit the level of grain reserves before 2000, g_u, to isolate exogenous variation in migration policies and provide causal estimates for their impact on the spatial distribution of migration barriers. In Table 8, we report the effects of two proxies for migration policies—the probability to convert registration at destination and a composite *hukou* stringency index—on the inferred migration barriers for migrants with and without family. We find that a marginal increase of 0.01 in the probability to convert registration at destination raises the value of a destination by about 6.2% for migrants without family (column 1) and 9.3% for migrants with family (column 2). A relaxation of 0.10 in the *hukou* stringency index similarly increases the value of a destination by 22% for migrants without family (column 3) and 32% for migrants with family (column 4). To better understand the welfare gap that policy induces across potential destinations, consider the median city in terms of restrictions versus the most restrictive city. This median city has a 0.10 higher registration conversion rate and a 0.30 lower *hukou* stringency index, compared to the most restrictive city—taking the latter measure, the median city is Zhuzhou (Hunan), and the most restrictive is Beijing. Our previous estimates would imply that such a policy gap would translate into a very large welfare gap, equivalent to a 150% increase in real wages for family migrants and an 86% increase for migrants without family.[31]

In summary, migration policy induces significant costs, especially so with family and in the (numerous) destinations with high institutional barriers. We quantify next how such frictions shape the extent, nature, and spatial distribution of migration in China.

6 The role of displaced consumption and frictions in shaping migration

In this final section, we describe how displaced consumption and the spatial distribution of migration frictions affect whether rural workers migrate, how they do so (with and without their family), and where they decide to go. We also explore the normative implications of our analysis, we consider extensions allowing for agglomeration and congestion externalities, and we discuss the novelty of our insights relative to those obtained using alternative, more standard modeling choices.

distance between origins and destinations, and disamenities at destination such as pollution or urban sprawl/commuting costs.

[31] These estimates come from the following calculations: a 0.10 higher registration conversion rate reduces the value of migration barriers, τ_{jru}, by 0.62 for migrants without family and 0.93 for migrants with family. Given our modeling assumptions, τ_{jru} is expressed in (log) units of real wages: These increases would correspond to a $(\exp(0.62) - 1) \times 100 \approx 86\%$ increase in real wages for migrants without family and a $(\exp(0.93) - 1) \times 100 \approx 150\%$ increase for migrants with family.

6.1 The role of displaced consumption

We first explore the specific role of (i) displaced consumption and (ii) price differentials between origins and typical destinations in explaining the migration patterns observed in China. We shut down this crucial mechanism by simulating the effect of a prohibitive tax on remittances that forces migrants to consume all their income at destination, irrespective of whether they move with or without their family.[32]

We present the effect of this thought experiment in the first panel of Table 9 (Counterfactual 1). Without the possibility to remit, the value of migration significantly decreases, leading to an overall decline in migrant numbers from about 27 million migrant households between 2000 and 2005 to around 12 million (column 1). The decline is, however, not homogenous across cities and migration modes. Forcing migrants to consume at destination disproportionately hurts those leaving family behind and those who choose high-price cities. First, the number of migrant households leaving family behind decreases from 22 to 7 million, while the number of family migrants remains relatively stable (from 5 to 4.6 million, see columns 2 and 3). The incidence of family migration thus increases from 18% within all migrant households to about 40% (column 4). Second, the concentration of migrants across cities markedly decreases compared to the baseline: the elasticity between migration concentration and prices at destination decreases from about 1.6 to 0.8.[33] Third, this experiment has strong distributional effects between rural- and urban-born households and across residents of different cities. The welfare of the numerous rural-born households would decrease by 1.3%, while the welfare of urban-born households would increase by 1.6%.[34] The latter hides a wide disparity across cities: The semi-elasticity of welfare gains for urban-born households to rents at destination is large, around 3, implying that urban residents in smaller cities would not experience any

[32]We follow the same five-step procedure to produce every counterfactual experiment: (1) we translate a policy change into changes in our estimated parameters or migration costs, e.g., by adjusting the computation of real wages or of migration frictions using estimates from Table 8; (2) we then compute the counterfactual emigration rates with or without family and from each origin to each destination; (3) we aggregate these flows at the level of each destination to compute counterfactual immigration rates; (4) based on these immigration rates, we compute changes in urban wages and rents using estimates from Table 7; and (5) these changes in wages and rents imply changes in the value to migrate to each location, which in turn will change migration decisions. We repeat these five steps until an equilibrium is reached, i.e., when the sum of squared deviations between the (log) immigration rates from one iteration to the next is less than a small number (0.001).

[33]We shed light on the distributional effects of our counterfactual experiments in two ways. We first report summary statistics in Table 9: (i) the elasticity of migrant concentration to the rent at destination in column 1, (ii) the semi-elasticity of family migration to the rent in column 4; and (iii) the semi-elasticity of welfare gains/losses to the rent in column 6. We also replicate the empirical facts of panel (b) of Figure 2 and panel (a) of Figure 3 in Appendix E.1, together with a display of the welfare gains/losses of urban-born households across cities.

[34]Rural-born households constitute more than 80% of our sample in 2005; the remainder are urban-born households with a local *hukou*. Note that rural-urban migration is massive, such that the urbanization rate is around 50%.

changes in welfare when residents of very large cities would see a flight of migrants and experience welfare gains around 5%.

Table 9. The role of migration frictions in shaping migration—counterfactual experiments.

	Migrant households (millions)				Welfare (% rel. baseline)	
	All	No fam.	Fam.	Fam. sh.	Rural	Urban
Baseline	27,29	22,27	5,02	0.184	-	-
	1.573			*-0.160*		-
			1. Shutting down remittances			
Counterfactual (1)	11,73	7,05	4,67	0.399	-1.280	1.576
	0.796			*-0.023*		*3.011*
			2. The role of migration frictions			
Counterfactual (2a)	58,10	40,64	17,46	0.301	2.740	-1.868
	2.123			*-0.160*		*-3.191*
Counterfactual (2b)	29,48	19,66	9,81	0.333	0.190	-0.240
	1.597			*-0.104*		*-0.274*
			3. The 2014 reform			
Counterfactual (3)	21,75	18,24	3,51	0.161	-0.460	-0.066
	1.310			*-0.113*		*0.706*

Notes: This Table reports statistics on the extent, nature, and consequences of migration flows in the baseline and in counterfactual experiments (1), (2a), (2b), and (3). Across all experiments, we report: the number of migrant households (overall in column 1, without family in column 2, with family in column 3, all reported in millions of migrant households between 2000 and 2005); the share of migrants living with family in column 4; the welfare of rural-born households in column 5 (in % relative to the baseline); and the welfare of urban-born households in column 6 (in % relative to the baseline). Note that rural-born households constitute about 81% of our sample in 2005. We also report the following additional quantities in italics: (i) the elasticity of migrant concentration to the rent at destination in column 1—as previously illustrated in panel (b) of Figure 2; (ii) the semi-elasticity of family migration to the rent at destination in column 4—as previously illustrated in panel (a) of Figure 3; and (iii) the semi-elasticity of welfare gains/losses (relative to the baseline) to the rent at destination in column 6. These quantities allow us to measure migrant concentration, family migration, and urban winners/losers across cities. The reader interested in these relationships will find detailed Figures in Appendix E.1 for all counterfactual experiments. We also provide additional statistics for experiments (1), (2a), (2b), and (3), i.e., their effect on wages and rents at destination and on the amount that is remitted from urban locations to rural origins.

This experiment evaluates and quantifies a general determinant of migration in transforming economies (and one of the main arguments of the present research): In settings with very large differences in living standards between origins and destinations, migrants have incentives to displace part of their consumption. The untangling of production and consumption has consequences on how and where they migrate. They can target congested cities where labor returns are high and where they can limit expenses by leaving their relatives behind. Counterfactual experiment (1) shows that the most salient features of rural-urban migration in China—which we document in Section 3—would partly vanish without these consumption imbalances.

Our subsequent counterfactual experiments will instead isolate the effects of migration *policies*, e.g., the decentralized *hukou* policy prior to 2014 or its moderate adjustment in 2014, on the extent and nature of migration in China.

6.2 The role of migration frictions and policies in shaping migration

We now assess the overall effect of *hukou* policies on rural-urban migration in China and the (ambiguous) impact of the 2014 reform, tightening restrictions in a few mega-cities and relaxing them in less populated urban agglomerations.

Migration frictions and migration patterns in China China has been imposing policies restricting internal migration since 1958, and these policies have changed over the course of its economic development. For these reasons, quantifying their dynamic and combined role is difficult. We simplify the analysis by restricting our attention to migration flows between 2000 and 2005 (our baseline period) and by ignoring dynamic considerations (e.g., substitution in migration flows across periods). In the Reform era, China devolved to local governments the power to devise migration policies—in practice, more or less stringent restrictions on the use of public services, the access to housing in cities, and the possibility to convert registration at destination. In this set of counterfactual experiments, we simulate instead the effect of a blanket, lenient policy calibrated on moderately restrictive cities. More specifically, we use our causal mapping between migration policies and the estimated migration barriers (see Table 8), and we adjust migration policies as captured by the probability to convert registration (r_u) to be at least equal to that of the 50$^{\text{th}}$-percentile prefecture ($\bar{r}$). Table 8 shows that such a shift would affect both migrants moving with family and migrants living alone at their destination, even though to a lesser extent for the latter.

In counterfactual experiment (2a), we model the effect of a policy that would lower restrictions for both migration modes, i.e.,

$$\tau'_{jru} = \tau_{jru} + \alpha_j \times \max\left(\bar{r} - r_u, 0\right),$$

where α_j is the mode-specific adjustment of (dis)amenities τ_{jru}. Intuitively, policy (2a) removes policy restrictions across migration modes "in excess of" the median prefecture. In counterfactual experiment (2b), we model the effect of a family-friendly policy that only removes the family-specific penalty at destination, i.e., we consider:

$$\tau'_{2ru} = \tau_{2ru} + (\alpha_2 - \alpha_1) \times \max\left(\bar{r} - r_u, 0\right).$$

Intuitively, policy (2b) only relaxes the family-specific component of restrictions, by making family migrants as sensitive as single migrants (i.e, less sensitive) to those policy restrictions "in excess of" the median prefecture.

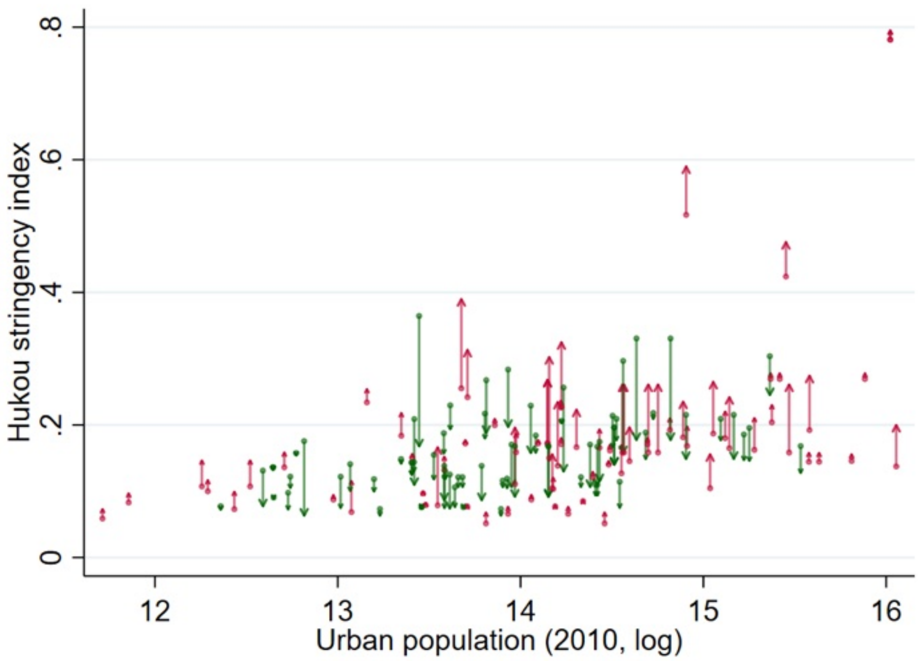
We report the differences implied by counterfactual experiment (2a) in the second panel of Table 9. The overall loosening of migration restrictions would lead to a large increase in migration flows: about 58 million migrant households would leave their rural origins between 2000 and 2005 against 27 million in the baseline. While most of these new migrant households would be moving without family, the relative incidence of family migration increases from about 0.18 in the baseline to 0.30, illustrating that family migration is more responsive to policy restrictions. Migrant concentration would be even more pronounced than the one documented in panel (b) of Figure 2. Finally, such a reform would have significant redistributive effects: The average welfare of (the more numerous) rural-born households would be 2.7% higher than in the baseline; and the average welfare of (the less numerous) urban-born households would be 1.9% lower than in the baseline, with most of these losses being concentrated in large urban agglomerations.

The relaxation of the family penalty—counterfactual experiment (2b)—would induce a more moderate, yet sizable, response: 2,500,000 additional migrant households would move to cities, and this additional inflow would be entirely explained by family migrants (see Table 9). In fact, cities would have fewer migrants living without family, compared to the baseline—an adjustment explained by the relative strengths of a pull effect (migration appears more desirable as a whole in the upper nest of the location choice model) and a strong substitution effect (family migration is much more desirable relative to the baseline). We thus find that the pure family component of migration policies in the early 2000s (e.g., the restricted access to schools) had a negative, yet limited, effect on the *number* of migrants; they had a marked effect on the *mode* of migration spells: Under more family-friendly policies, a third of migrant spells would be family migration, and the number of left-behind children would be markedly lower (Gao et al. 2022).

In summary, the decentralized migration policies of the early 2000s had a deterrent effect on migration; our quantitative model further shows that they had a targeted deterrent effect on family migration toward high-return cities.[35]

[35] Appendix E.1 sheds additional light on the redistributive aspects of migration policies. We first provide evidence on the counterfactual migrant concentration and family migration incidence as a function of rents at destination (in the spirit of Figures 2 and 3), and we show the distribution of welfare gains/losses for urban-born households across cities. We further document the spatial distribution of welfare gains/losses and changes in family migration, as induced by counterfactual (2a), in maps nested at the destination or origin level. These maps show that *hukou* restrictions of the early 2000s protected urban people along the coast at the expense of rural people in Central China, pushing many of them to leave children behind when migrating to these coastal cities. Finally, we compute the distribution of welfare for urban-born and rural-born households across the main counterfactual exercises to understand the redistributive effects of migration policies.

Figure 7. The 2014 *hukou* reform



Note: This Figure shows the distribution of the *hukou* reform, as captured by $h_{u,a} - h_{u,b}$, across cities of different size (see Zhang et al. 2018, for a description of indices, $h_{u,a}, h_{u,b}$). Positive changes in restrictions are indicated in green; negative changes in restrictions are displayed in red.

The 2014 *hukou* reform In our last counterfactual experiment, we evaluate the *hukou* reform of 2014. We rely again on our causal mapping between migration policies and migration barriers, but we now exploit columns 3 and 4 of Table 8. Indeed, Zhang et al. (2018) did not only measure migration restrictions before 2014 ($h_{u,b}$)—used as the explaining variable in columns 3 and 4—but also after 2014 ($h_{u,a}$). In other words, we can model the effects of the policy for $j \in \{1, 2\}$ as follows:

$$\tau'_{jru} = \tau_{jru} + \beta_j \times \left(h_{u,a} - h_{u,b}\right),$$

where β_j is the mode-specific adjustment of (dis)amenities τ_{jru} to the *hukou* index. We display in Figure 7 the distribution of $h_{u,a} - h_{u,b}$ across cities of different size: While the 2014 reform generally relaxed migration restrictions, the relaxation was much more significant in small- and medium-size urban destinations. In effect, migration regulations did become stricter in very large cities (an observation discussed in Gao et al. 2022).

We present the predictions of counterfactual experiment (3) in the last panel of Table 9. Our quantitative model allows this effect to be disciplined by the interaction of congestion forces, the substitution between migration modes, the multiple location model, and the general equilibrium. We find that the 2014 *hukou* reform leads to a limited *decrease* in migration, but its effect is ambiguous: Small- and medium-size cities attract more migrants at the expense of the largest cities. This reallocation of migrants is best observed in Appendix Figure E.4, which displays the reform effect on migrant concentration and welfare across cities (from the least expensive cities to the most expensive ones): The 2014 reform did lead to a dispersion of migrants from the most congested cities toward the other, smaller urban agglomerations. Its overall effect indicates, however, that it should not be interpreted as a relaxation of *hukou* policies. Migration barriers became smaller in a large number of cities, but not in those locations that are the most attractive to migrants; and the concentration of migrants documented in Section 3 is such that the tightening of restrictions in a few cities is sufficient to counteract the easing effect on most cities.

6.3 Discussion

This section summarizes our main findings about: (i) the normative implications of displaced consumption and migration frictions with a focus on their redistributive effects; (ii) model extensions allowing for agglomeration and congestion externalities; and (iii) the quantitative and qualitative insights induced by our precise modeling of migration and consumption choices relative to alternative, standard models of location choice.[36]

Normative implications and redistributive effects Our setting is one with very significant variation in living standards across space—between rural and urban dwellers, and across cities. At the onset of the 2000s, China became a leading exporter, and the fast economic development induced wide regional disparities. The drivers of this growth were large cities and new exporting regions, all located along the coast.

In Appendix E.1, we quantify the welfare implications of (a) migration restrictions and (b) the possibility for rural-urban migrants to lower living costs in booming cities. We show that migration restrictions acted as a strong regressive policy, increasing the welfare of urban residents located in the most attractive cities at the expense of a large population of rural households in the hinterland. These frictions prevented rural-urban migration to a large extent, but many rural dwellers still migrated toward these attractive cities. We find that they did so by leaving family behind, incurring non-negligible bilateral migration costs. Appendix E.1 shows that the ability to displace consumption significantly mitigates the impact of these regressive migration policies. More specifically, it reduces welfare inequalities between urban-born and rural-born households and across urban-born households from different cities; it however slightly increases the welfare disparities across rural-born households, benefiting rural households in the

[36] The reader interested in redistributive effects, the role of externalities, and modeling alternatives can refer to Appendix E.1, E.2, and E.3, respectively.

hinterlands of expensive cities.

Introducing externalities The heterogeneous growth of cities is possibly disciplined by agglomeration and congestion forces. Our baseline quantitative model only features such forces through the (equilibrium) adjustment of labor and housing markets.

In Appendix E.2, we show that agglomeration economies (e.g., through positive production spillovers from rural migrants) or congestion externalities (e.g., through negative spillovers on local amenities) would affect our quantification exercise at the margin. The former would predict a slightly larger effect of relaxing migration restrictions on migrant inflows, with rosier welfare implications across the board. The latter would predict the exact opposite effects. Both externalities have limited bite, because their effects are dwarfed by the other drivers of migration, i.e., the large rural-urban income gaps and the significant bilateral migration costs. The most interesting extension allows for remittances to boost production at origin (as in Pan and Sun 2022, Khanna et al. 2022). This extension increases the social returns to migration, while decreasing its private return. In such a framework, migrants migrate less following the relaxation of restrictions than with our baseline model, even though the policy would have larger welfare effects, and migration subsidies might be welfare-enhancing.

Sensitivity analysis and alternative migration models Our modeling choices are motivated by the following observation. In environments with significant gaps in living standards between rural and urban areas and across cities—as is the case in most transforming economies,—households have incentives to migrate without family and displace part of their consumption back to their rural homes. This observation, coupled with empirical regularities discussed in Section 3, leads us to consider a location choice model allowing potential migrants to choose whether to migrate or not, how to migrate, and where, and giving them a technology to displace part of their consumption to origins.

In Appendix E.3, we illustrate the quantitative and qualitative insights gained through the adoption of those two novel features by estimating four alternative models: (1) a multinomial model of location choice (as in Bryan and Morten 2019, Tombe and Zhu 2019); (2) a nested model where rural households can decide whether to migrate or not, and where; (3) a nested model adding the possibility for migrants to remit (as in Albert and Monras 2022); and (4) a three-nest structure akin to our baseline model (i.e., with two migration modes and two associated technologies for the consumption of non-tradable goods), but where there is limited substitutability between migration modes. We show that both ingredients are instrumental in quantifying the effect of migration frictions. Intuitively, ignoring remittances or the choice of migrating with or without family leads to a misspecification of bilateral migration frictions. Models without remittances underestimate the possible impact of a relaxation of migration barriers and their heterogeneous effects across migration modes. By contrast, models with different migration modes but without accounting for substitutability between those would widely over-estimate the effects of such a relaxation.

7 Conclusion

This paper offers a new perspective on migration and migration policy. While most of the literature has studied how migration frictions, sometimes induced by policy, deter migration, we identify a novel impact of such restrictions: Migration institutions do not only limit the extent to which people migrate, but also how they do so. At heart, migrants face a decision between moving with their families to less expensive locations (maybe with higher amenities), or moving without their families to expensive, productive locations and remitting a significant share of their earnings.

We make this argument in the context of rural-urban migration in China. Chinese internal migration policies limit the extent to which rural families can fully migrate to urban settings. We use this setting to argue that the *hukou* system resulted in a concentration of rural migrants into the highest-wage, highest-rent, and potentially the most congested urban destinations. We also show how taking into account family migration decisions allows us to evaluate the role of policies in shaping the level and composition of migration.

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Floating population: migration with(out) family and the spatial distribution of economic activity

Online Appendix

A Data description

This section provides complements to Section 2: (i) a brief description of our data; and (ii) a lengthy discussion of the allocation of migrants, barriers to migration, and split families across space and over time.

A.1 Living conditions in cities

We collect data on living conditions in cities: pollution data from satellite images; commuting data from the “2015 Mini-Census”; and additional wage data for other years than 2005. We leave the description of additional data used for identification purposes to Appendix D.

Pollution Pollution data come from TEMIS satellite images and cover the period 1997–2015 with a 20-25 km resolution. We map raster data on NO_2 concentration, which captures industrial and exhaust gas pollution, to Chinese prefectures to create pollution concentration measures at the prefecture × year level. These measures can be interpreted as a proxy for air quality.

Commuting We also compute average commuting times at the prefecture level from a random 20% micro extract of the 2015 1% Population Survey. These data allow us to proxy for congestion.

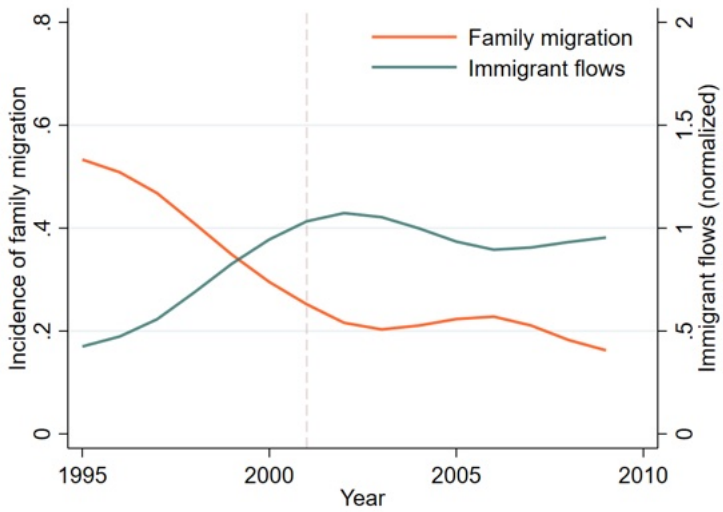
Statistical Yearbooks We use aggregate data compiled by the National Bureau of Statistics based on the Reporting Form System on Labor Wage Statistics, the National Monthly Sample Survey System on Labor Force, and the System of Rural Social and Economic Surveys (http://www.stats.gov.cn/tjsj/ndsj/2018/indexeh.htm) to extract measures of wages at baseline, in 2000.

A.2 Descriptive statistics

In this section, we provide complements to the main descriptive statistics discussed in Section 2.4.

Immigrant inflows and family migration over time Figure A.1 shows the composition and magnitude of immigrant inflows to urban areas between 1995 and 2010. Immigrant inflows accelerate around the time of WTO accession, coinciding with other reforms contributing to pushing migrants from rural hinterlands into growing metropolitan areas. After 2000–2001, urban areas experience a steady increase of population, and,

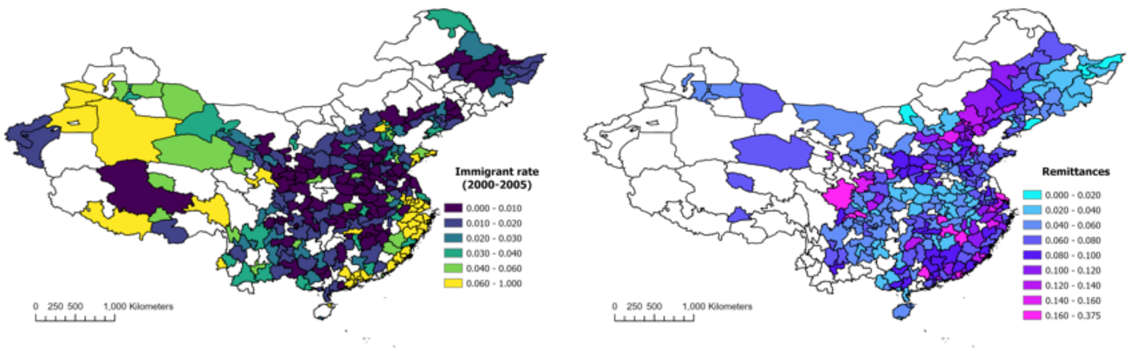
Figure A.1. Immigrant inflows and family migration over time.



Notes: This figure shows the composition and magnitude of immigrant inflows to urban areas between 1995 and 2010 using Population Censuses (2000, and 2010) and the "2005 Mini-Census." A migrant is defined as an individual whose prefecture of residence is different from her prefecture of household registration. The definition of family migration follows that of our baseline specification (a migrant living at destination with at least a parent or a child). The dashed line indicates the WTO accession of China in 2001. Note that there are two differences with Figure 1: Migration incidence is captured here by yearly flows; migrant flows are normalized by contemporary population in cities and set equal to 1 in 2000.

more importantly for our purpose, the composition of immigrant inflows appears to be stable over time: about 20% of new immigrants to cities are moving with their family.

Figure A.2. Immigrant inflows and remittances across prefectures in 2005.



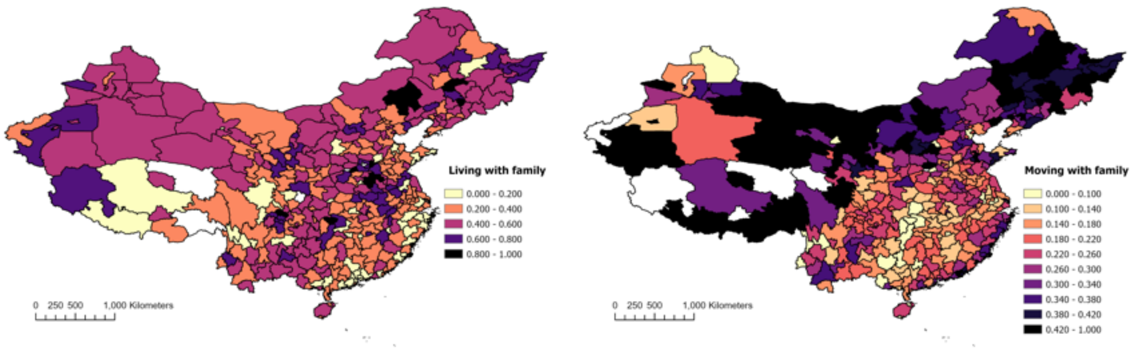
(a) Immigration rate

(b) Remittance share

Notes: Panel (a) displays the share of rural-urban immigrants in the 2005 1% Population Survey or "2005 Mini-Census" across urban prefectures. We restrict the sample to urban locations and define rural-urban immigrants as rural-*Hukou* holders at those urban locations. Note that the Western regions appear to have large immigrant shares, mostly because those are less populated areas. Panel (b) displays the share of income devoted to remittances across destinations (from CMDS, 2011–2012).

Immigrant inflows and remittances across space Figure A.2 displays the geography of migration to cities in China: the allocation of immigrants across space in 2005 in panel (a), and the remittance share across destinations in panel (b). Ignoring the Western, less populated areas, we see that migrants tend to go to large cities (Beijing, Shanghai) and to the new exporting centers: Tianjin, Fuzhou, and Shenzhen/Guangzhou in the South. From these favored destinations, migrants appear to remit larger fractions of their income (panel b of Figure A.2).

Figure A.3. Migration patterns across destinations and origins in 2005.



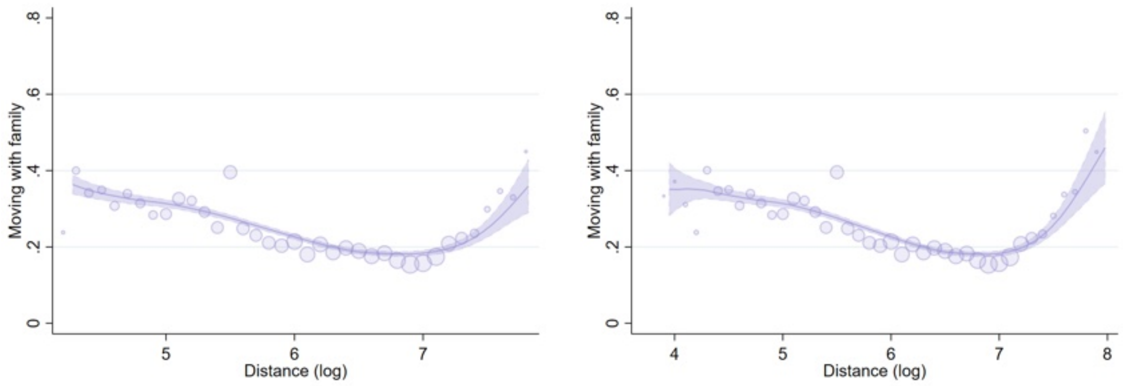
(a) Living with family (destination) (b) Moving with family (origin)

Notes: Panel (a) shows the variation in migration arrangements across destinations (share of immigrants living at destination with family). Panel (b) shows the variation in migration arrangements across origins (share of emigrants moving with family).

Migration patterns Figure A.3 shows that migration patterns strongly vary across space. First, the spatial distribution of migrants living with family across destinations (negatively) correlates with immigrant incidence and with the propensity to remit back to origins: In large cities and new exporting centers, migrants are also less likely to live with family—see panel (a). Second, the previous observation, coupled with the gravity of migration flows, induces spatial disparities in the share of migrants having moved with family from different origins and thus with the incidence of family members left behind by the main breadwinners—see panel (b). These geographic differences are very marked and illustrate a strong spatial heterogeneity in migration patterns across Chinese cities.

The gravity of migration flows has two distinct implications for the decisions of families to move jointly or remain split between two locations: (i) the proximity to congested locations with strong barriers to family migration induces a higher incidence of split families, for a given distance, as shown in panel (b) of Figure A.3; and (ii) the distance between origins and destinations does predict some of the incidence of the different migration patterns (see Figure A.4). In fact, the former effect is most predictive of family

Figure A.4. Migration patterns and distance in 2005.



(a) Distance (b) Travel time

Notes: Panel (a) shows the variation in migration arrangements (share of immigrants living at destination with family) across migration spells implying different geodetic distances between origins and destinations (as the crow flies). Panel (b) uses instead an indicator of distance based on travel time through the transportation network.

migration: Most population lives in Central China and along the coast, not so far from typical migration destinations, such that the higher incidence of family migration from very distant prefectures (see the right tails in Figure A.4) does not represent more than 1% of all migration spells.[37]

Migration barriers One crucial factor underlying the allocation of migrants and their families across space is the stringency of local barriers to migration (see Section 2.1). In this section, we first describe and compare the measures we use to capture such barriers. We then show how they reflect migrants' experiences at destination. Finally, we discuss the spatial distribution of *Hukou* stringency across cities and how this distribution was affected by the 2014 reform.

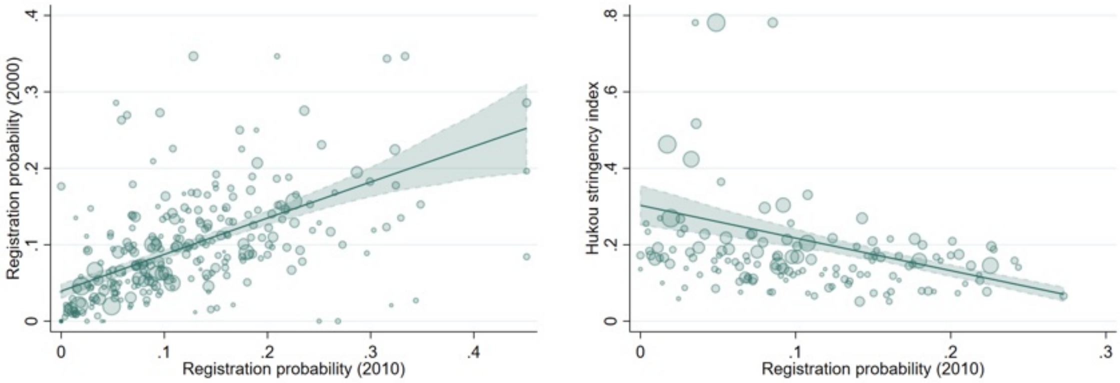
In the paper, we use two measures of the local regulatory environment affecting immigration. First, we follow Wu and You (2021) and use census data to compute the share of migrants between 15 and 64 years old, having moved for work-related reasons, and born in another county, who were registered locally with a non-agricultural *Hukou*. This gives us a city-level measure of the probability for immigrants to convert their household registration at destination; we denote it by r_u.[38] Second, we use the composite indices from Zhang et al. (2018), who collated local regulations and policy documents to quantify how easily migrants can obtain local household registration at destination.

[37] Western and northern families might also be more likely to move jointly with their family, because nearby cities are cheaper and with less stringent *Hukou* restrictions.

[38] Census data do not record past *Hukou* types. This measure thus assumes away urban-urban migration.

These indices are available for two periods: before (2000–2013) and after (2014–2016) the landmark 2014 *Hukou* reform, and for 124 cities; we denote those indices by $h_{u,a}$ and hu, b for the pre- and post-2014 periods, respectively. In Section 5, we rely on the registration probability measure from the 2010 Census,[39] and in Section 6, we leverage legislation-based indices to estimate the effect of the 2014 *Hukou* reform in a counterfactual exercise.

Figure A.5. Measures of the *Hukou* environment.



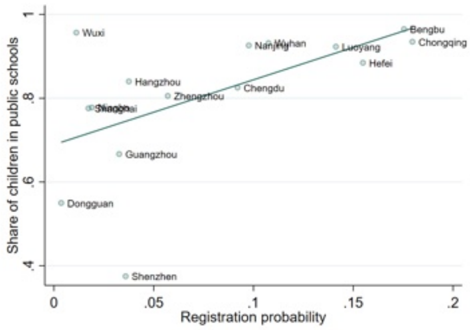
(a) Registration probability, r_u (b) *Hukou* index, $h_{u,a}$

Notes: Panel (a) shows the correlation between the census-based measures of local household registration probability for 2000 and 2010, following Wu and You (2021). Panel (b) shows the correlation between the pre-2014 *Hukou* stringency index developed by Zhang et al. (2018) and the household registration probability for 2010. A bubble is a prefecture of destination and is weighted by its initial urban population in 2000. The lines are local polynomial fits, where each observation is weighted by population.

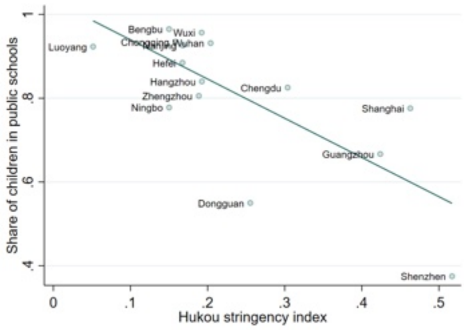
We show the correlations between measures of the *Hukou* environment in Figure A.5. Panel (a) plots the registration probability in 2000 against that in 2010 (our main measure of the *Hukou* environment), using census data. We see that the two measures are strongly, positively correlated, which illustrates the presence of inertia in local legislation, despite the fast growth in immigration in that period (see Figure 1). Nonetheless, the majority of prefectures lie below the 45-degree line, which implies that many prefectures eased restrictions on *Hukou* conversion between 2000 and 2010. This measure of the *Hukou* environment is however a complex equilibrium object, as it is based on observed, and therefore selected, immigration. In panel (b), we correlate our measure of registration probability in 2010 with the composite index from Zhang et al. (2018), which instead relies on a coding of legislation rather than on observed migration and conversion probability. As expected, the two measures are strongly negatively correlated, which suggests that they do capture the leniency and stringency, respectively, of the local *Hukou* environment.

[39]The "2005 Mini-Census" does not contain information on the place of birth. Results are unchanged if we measure the registration probability in 2010 instead.

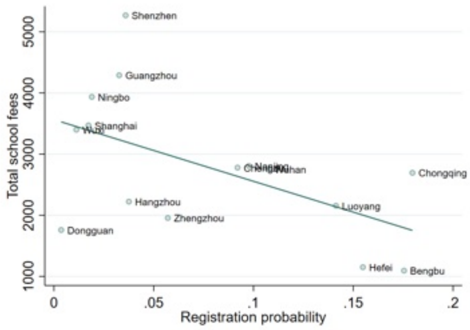
Figure A.6. Access to public goods and the *Hukou* environment.



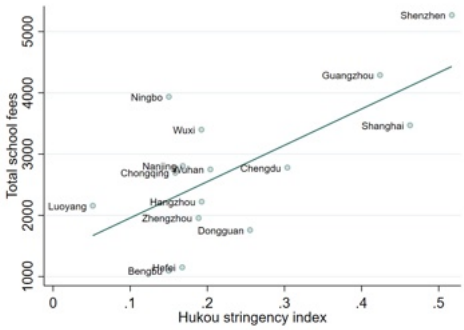
(a) Access to schools (r_u)



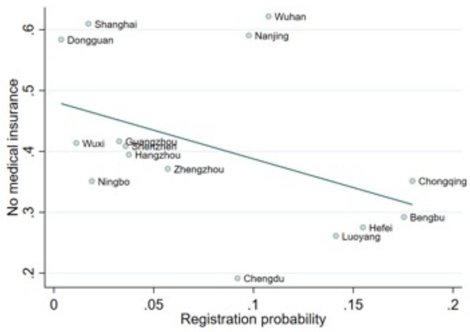
(b) Access to schools ($h_{u,a}$)



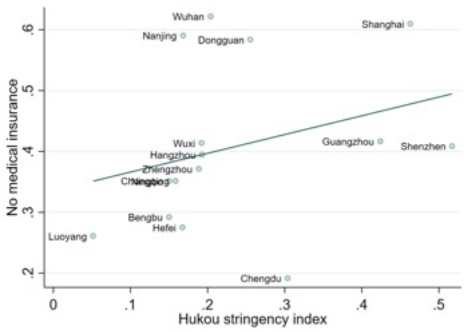
(c) School fees (r_u)



(d) School fees ($h_{u,a}$)



(e) Medical insurance (r_u)

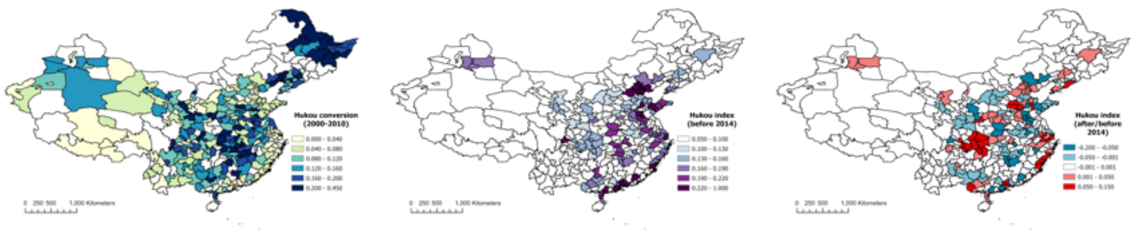


(f) Medical insurance ($h_{u,a}$)

Notes: This figure shows the correlation between measures of access to public goods from the 2007 CHIP rural migrant survey and measures of the leniency or stringency of the *Hukou* environment. The latter is captured by the census-based measure of local household registration probability for 2010, following Wu and You (2021), and by the pre-2014 *Hukou* stringency index developed by Zhang et al. (2018), in left (r_u) and right panels ($h_{u,a}$), respectively. A dot is a prefecture of destination. The lines are local polynomial fits. "Share of children in public schools" is the share of migrant households' children who attend public schools, conditional on living at destination. "Total school fees" includes tuition fees, the cost of food, the cost of remedial classes taken at schools, and other fees (e.g., school uniform); it excludes sponsorship, boarding, and selection fees. "No medical insurance" is the share of immigrant household heads who do not have any medical insurance.

An important caveat of both census- and legislation-based measures is that they rely on *Hukou* conversion, which remains a rare event for rural migrants, in particular for the average—low-income, low-education—migrant. Cities typically condition local registration on migrants' meeting a set of stringent criteria, e.g., investing more than one million RMB in an enterprise or having a college degree. In Figure A.6, we leverage an additional dataset, the 2007 China Household Income Project (CHIP) rural-urban migrant survey, which constitutes a representative survey of migrant workers and their households in 15 cities in nine provinces,[40] to investigate whether our *Hukou* conversion measures are good proxies for the experiences of rural migrants at destination, i.e., for their access to public goods. We display in Figure A.6 correlations using the census-based registration probability in left panels and the legislation-based *Hukou* index in right panels. The top two panels show the correlation of the probability for migrants' children (conditional on living at destination) to attend public schools with the *Hukou* environment at destination. We see that cities that are characterized by a tougher stance on migrant *Hukou* conversion are indeed more likely to restrict migrants' access to public goods. The middle panels show that, conditional on going to school at destination, migrants' children pay higher school fees in more restrictive *Hukou* environments.[41] Turning to healthcare as another major public good that migrants are known to have limited access to in urban China, the bottom panels show that immigrants in more stringent *Hukou* environments are much less likely to have a medical insurance.

Figure A.7. Migration barriers across prefectures.



(a) *Hukou* conversion (2010) (b) *Hukou* index (before 2014) (c) *Hukou* change (pre-post 2014)

Notes: Panel (a) shows the variation in *Hukou* conversion between 2000 and 2010, r_u—a measure constructed following the procedure developed in Wu and You (2021). Panel (b) uses the composite index capturing the ease with which migrants could obtain a local urban *Hukou* before 2014, $h_{u,a}$ (Zhang et al. 2018). Panel (c) uses the differences in such composite indices after 2014 compared to the pre-reform period, $h_{u,b} - h_{u,a}$.

We finally shed some light on the spatial distribution of barriers to internal migration in Figure A.7 with: (i) the measure of *Hukou* conversion from the 2010 Census in panel (a);

[40] Given the absence of a sampling frame, CHIP selected migrant respondents in the following way: (i) they randomly sampled enumeration areas within each city, (ii) they listed all workplaces within each enumeration area, (iii) they collected information on the number of staff and the number of migrant workers from each workplace, and (iv) they randomly selected migrant workers to participate in the survey (Meng and Manning 2010).

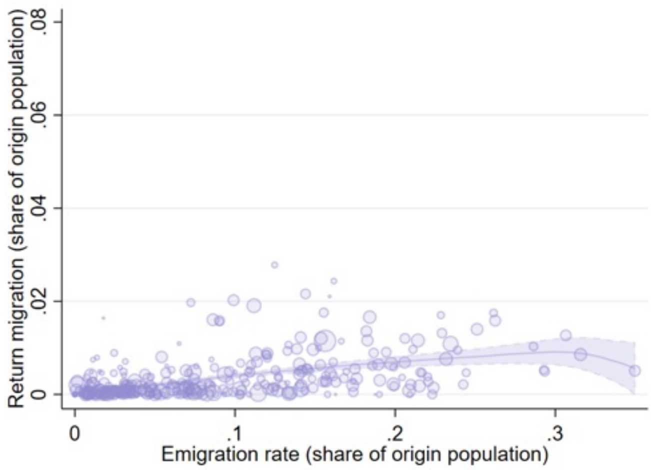
[41] Similar patterns obtain if we focus on tuition fees, i.e., excluding the cost of food, remedial classes, and other fees included in total fees.

(ii) the composite index capturing the ease with which migrants could obtain a local urban *Hukou* before 2014 (Zhang et al. 2018) in panel (b); and (iii) the differences in the composite indices after 2014 compared to the pre-reform period in panel (c).

Migration barriers coincide more or less with the allocation of economic growth during the Reform period. Indeed, the extent to which prefectures constrain access to public services depends on the expected fiscal deficits and (historically) on possible food shortages if they were to allow for migration. Such deficits are thus tied to expected migration (very correlated with local growth prospects) and to fiscal balance and food reserves. In Section 5, we exploit the latter to isolate exogenous variation in the allocation of migration barriers across space.

In 2014, the government implemented a *Hukou* reform (exploited in Gao et al. 2022, in order to uncover its effect on left-behind children) with the aim of displacing rural migrants from congested cities to smaller agglomerations. Panel (c) of Figure A.7 shows that large metropolitan areas (e.g., Beijing, Shanghai, Shengzhen/Guangzhou, Fuzhou, etc.) experienced a tightening of restrictions when satellite cities experienced a loosening of barriers. We discuss the subtle effect of such a reform on the allocation of migrants in Section 6.

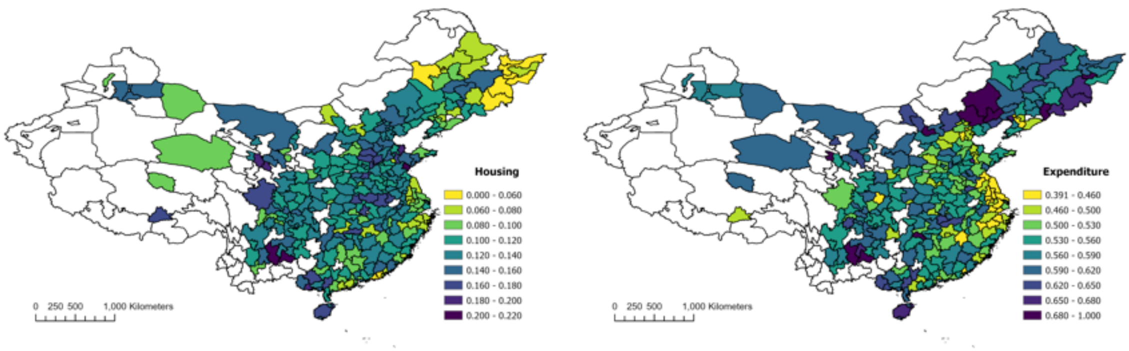
Figure A.8. The incidence of return migration.



Notes: This Figure compares the number of migrants having departed from their origins after 2000 (x-axis) to the number of those having returned between 2004 and 2005 (y-axis) across prefectures.

Return migration An intriguing feature of rural-urban migration in China, given the institutional constraints to settling in cities, is the low incidence of return migration. One factor could be the lack of non-agricultural employment opportunities in rural hinterlands (in spite of the effect of remittances documented in Pan and Sun 2022). We quantify the incidence of return migration in Figure A.8, where we compare the number of migrants having departed from their origins after 2000 to the number of those having returned between 2004 and 2005. In rural areas where about 10% of the rural population left during this period, only about 0.3% returned.[42] We further discuss return migration and the prospects of movers in Appendix B.8, where we show that most of them would prefer to stay at destination even when currently leaving the family behind.

Figure A.9. Consumption of non-tradables and expenditure shares of migrants across space.



(a) Housing share

(b) Expenditure share (excl. remittances)

Notes: Panel (a) displays the share of income devoted to housing expenditures across destinations (from CMDS, 2011–2012; the measure includes the employer contribution if housing is provided by the employer). Panel (b) displays the ratio of expenditures (from CMDS, 2011–2012; excluding remittances) to income.

Robustness and alternative definitions We now discuss a few robustness checks. We first provide a sensitivity analysis of Figure A.2 by displaying alternative measures of (displaced) consumption in Figure A.9. We first extract the share of income devoted to housing in panel (a) and find that favored destinations, where migrants appear to remit larger fractions of their income, are also places where they spend less on housing. They do not only spend less on housing: They consume less as a whole. We indeed show in panel (b) of Figure A.9 that the ratio of consumption to income is lower in the most-favored destinations.

In the paper, we use a baseline dichotomy to characterize migration spells and we distinguish migrants living with family (i.e., with at least one parent or child) from migrants living without family at their destination. In practice, there are many different arrangements, some involving the migration of one spouse only, others involving both

[42] Imbert et al. (2022) further studies the patterns of return migration in the "2005 Mini-Census," e.g., allowing them to infer the extent of return migration between 2000 and 2005 rather than between 2004 and 2005 only. The conclusion remains that return migration is one order of magnitude lower than migration flows.

parents—thus leaving children with their grandparents. In Table A.1, we replicate Table 1 and report four other splits of the data: one that distinguishes migrants living with children from those living without children; one that distinguishes female migrants living with children at destination from having left their children at origin (thereby focusing on females with children only, using the fertility module of the "2005 Mini-Census"); one that distinguishes migrants living with any relative from those living without relatives; and one that distinguishes migrants living with a spouse from those living without a spouse. The findings are quite consistent with our baseline dichotomy. Interestingly, we find that migrants who move *alone* are the ones with the largest number of co-residents: They indeed tend to live in dorms or in shared, low-quality accommodation.

Table A.1. Descriptive statistics—living arrangements.

	Children		Children (f)		Spouse		Relatives	
	With	Without	With	Without	With	Without	With	Without
Panel A: Demographic characteristics								
Age	36.08	30.12	35.61	35.40	35.20	29.86	35.13	28.97
Female (head)	0.220	0.397	1.000	1.000	0.095	0.467	0.188	0.471
Married	0.987	0.609	0.992	0.988	0.999	0.566	0.961	0.515
Number of children	1.691	1.428	1.687	1.605	1.433	1.499	1.592	1.437
Number of children (OCP*)	1.643	1.354	1.643	1.530	1.333	1.436	1.508	1.379
Panel B: Education								
High school (at least)	0.133	0.188	0.129	0.105	0.151	0.186	0.146	0.196
College (at least)	0.011	0.022	0.010	0.007	0.014	0.022	0.014	0.024
Panel C: Economic characteristics								
Income (head, RMB)	1,196	1,024	1,186	969	1,175	1,012	1,154	1,000
Hours worked per week	55.32	55.53	55.31	56.11	55.83	55.34	55.61	55.41
Housing share	0.232	0.213	0.226	0.234	0.162	0.230	0.199	0.224
Panel D: Living arrangements								
Co-residents	3.106	2.779	3.281	2.203	2.747	2.893	2.673	2.967
No kitchen	0.388	0.594	0.385	0.541	0.465	0.583	0.444	0.618
No toilets	0.545	0.573	0.544	0.613	0.593	0.556	0.576	0.561
House ownership	0.174	0.047	0.172	0.071	0.115	0.059	0.130	0.039
Panel E: Location characteristics								
City income (RMB)	711	862	715	822	762	857	754	879
Observations	12,952	46,231	9,999	15,388	17,234	41,949	23,525	35,658
	0.218	*0.782*	*0.393*	*0.607*	*0.291*	*0.709*	*0.397*	*0.603*

Notes: The sample is restricted to household heads aged 15–64 and living in urban areas (2005 1% Population Survey). In columns 1 and 2, we distinguish those having moved with children or not (for women with children in columns 3 and 4); in columns 5 and 6, we distinguish those having moved with a spouse or not; and in columns 7 and 8, we distinguish those having moved with some relatives or not. Descriptive statistics for *Monthly income (RMB)* and *Hours worked per week* are restricted to individuals who reported positive working hours in the past week. *Number of children alive* is available for female respondents (OCP* excludes females who were above 25 when the One-Child-Policy was adopted). *Housing share* is based on the predicted outcome from a regression of monthly rent (in log) for respondents renting in commercial housing on prefecture fixed effects interacted with various characteristics of the dwelling.

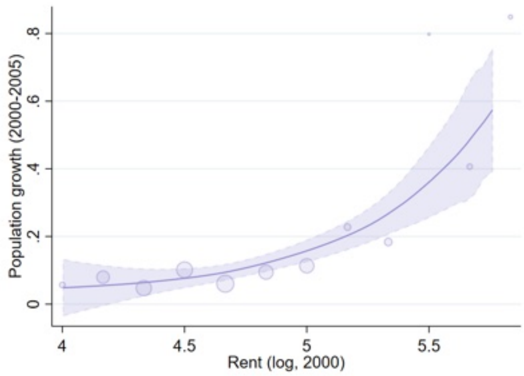
B Complements to the empirical analysis

This section provides some motivational evidence discussed in the introduction and complements to Section 3.

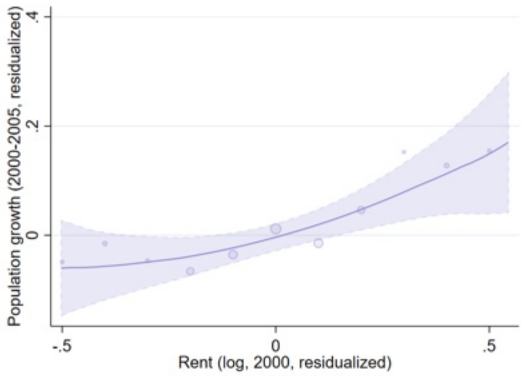
B.1 Motivational evidence

In this section, we shed some light on the predictors of population growth for urban areas in China, just before the WTO accession and land reforms that precipitated the migration of rural inhabitants to cities. We focus in particular on local prices, as captured by housing rents, to illustrate the apparent puzzle at the core of our analysis: migrants appear to sort in expensive cities.

Figure B.1. Correlation between population growth and housing rents.



(a) Baseline



(b) Residualized

Notes: This Figure shows the correlation between population growth across prefectures between 2000 and 2005 and initial rental prices. Panel (a) shows the unconditional correlation, where prefectures are grouped by bins of initial rental prices. Panel (b) nets out other potential drivers of population growth—see the control variables used in Table B.1.

This sorting is due to two factors: (i) omitted variation, as expensive cities typically offer high wages; and (ii) the consumption patterns of migrants, especially when they move without their family. We better discuss these stylized facts in Section 3, provide a theoretical framework to think about migration decisions in Section 4, and carefully estimate a migration choice model in Section 5. We present here the unconditional and conditional correlations between population growth and initial rental prices (see Figure B.1 and Table B.1).

Table B.1. Correlates of population growth between 2000 to 2005.

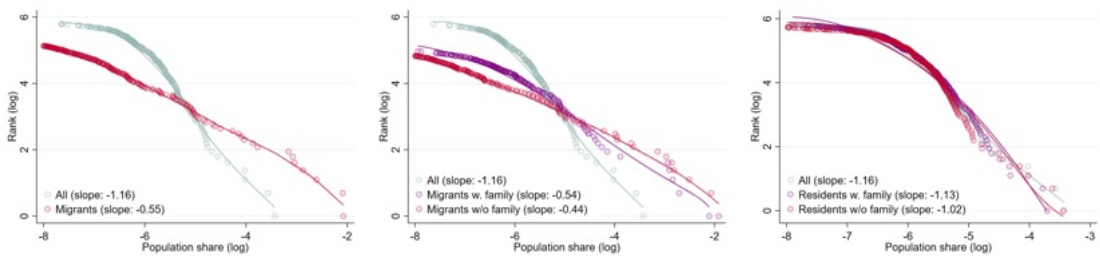
Growth (2000-2005)	(1)	(2)	(3)	(4)	(5)	(6)
Rent (log, 2000)	0.158	0.105	0.131	0.132	0.129	0.209
	(0.054)	(0.072)	(0.071)	(0.054)	(0.056)	(0.070)
Rent (log, 2005)						-0.083
						(0.053)
Wage (log, 2005)						0.064
						(0.045)
Pollution (2000-2005)						-0.115
						(0.100)
Wage (log, 2000)		0.130	0.143			
		(0.066)	(0.069)			
Pollution (1997-2000)		0.035	0.041	0.013	0.012	0.152
		(0.022)	(0.021)	(0.023)	(0.025)	(0.111)
TFP (log, 2000)				0.012	0.001	-0.025
				(0.058)	(0.059)	(0.056)
Geo. constraints				0.220	0.213	0.161
				(0.178)	(0.183)	(0.186)
Geo. × TFP				0.114	0.113	0.076
				(0.197)	(0.203)	(0.212)
Bartik shock					0.002	0.001
					(0.004)	(0.004)
Trade shock					0.159	0.161
					(0.266)	(0.282)
Population (log, 1990)			-0.050			-0.045
			(0.018)			(0.020)
R-squared	0.071	0.133	0.172	0.087	0.094	0.142

Notes: A unit of observation is a prefecture in 2005. Robust standard errors are reported between parentheses. The dependent variable is the population growth in urban areas at the prefecture level between 2000 and 2005. The sample is constituted of 272 prefectures; the construction of dependent variables is better described in Section 2 and Appendix A.

B.2 The concentration of migrants across cities

In this section, we document the extent to which migrants, especially when they move without family, concentrate in a few cities. To do so, we rely on the so-called Zipf law of city size, which conjectures that (log) population should be linearly related to the associated (log) rank and that the coefficient of such a linear relationship should be -1.

Figure B.2. The concentration of migrants across cities.



(a) Migrants and residents (b) Migrants with children (c) Residents with children

Notes: The x-axis reports (log) population by type (all, migrants, etc.) across prefectures using the "2005 Mini-Census"—note that we normalize the population by type to sum to 1 across all prefectures. The y-axis reports the associated (log) rank of these prefectures. The Zipf law of city size conjectures that (log) population should be linearly related to the associated (log) rank and that the coefficient of such linear relationship should be -1.

Panel (a) of Figure B.2 shows this relationship for all urban dwellers (green dots and line) and computed with rural migrants only (red dots and line). While the Zipf law of city size appears to hold for all urban dwellers, rural migrants are (much) more concentrated than the average urban dweller: The (relative) size of the migrant population is thrice as large in the most populated city relative to the average urban dweller (panel a). Panel (b) of Figure B.2 shows that migrants without family are even more concentrated—a gradient that is far less obvious when looking at urban dwellers with a local, urban *Hukou* (panel c).

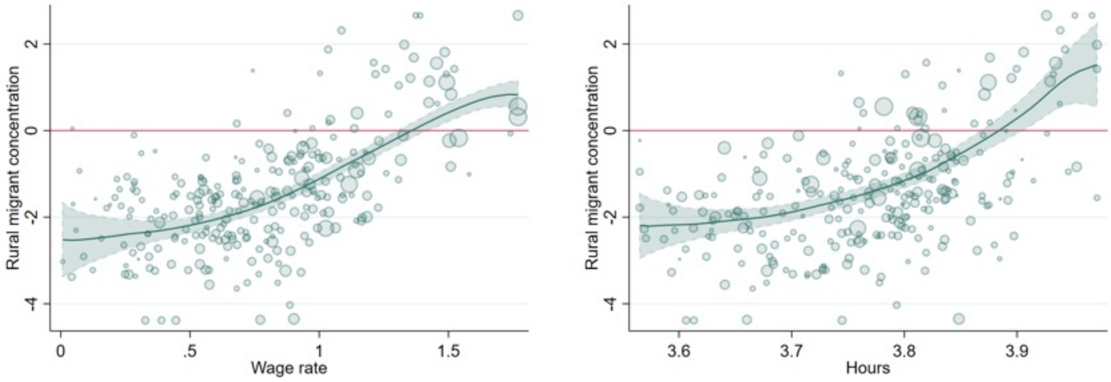
B.3 The sorting of migrants across cities

Our motivating evidence in Section 3 documents that migrants sort into cities where monthly wages are high.

In Figure B.3, we decompose this finding into two distinct effects: (i) migrants sort into cities where wage rates are high (i.e., the wage adjusted by the number of hours worked during a normal week); and (ii) migrants sort into cities where workers work longer hours. The latter effect is not negligible as workers in "highest-wage" locations appear to work between 25-30% more than in the "lowest-wage" locations.[43]

[43]One explanation could be that the substitution effect dominates the income effect for the relatively

Figure B.3. Rural migrant concentration, hourly wage, and hours worked.



(a) Hourly wage

(b) Hours

Notes: The y-axis reports the migrant concentration in city c, m_c, as defined in Section 3. In panel (a), the x-axis reports the (log) hourly wage rate; in panel (b), the x-axis reports a measure of (log) number of hours worked during a normal week. Hours and wages are constructed by aggregating individual responses from the 2005 1% Population Survey. A bubble is a prefecture of destination and is weighted by its initial urban population in 2000. The lines are local polynomial fits, where each observation is weighted by population.

In Figure B.4, we further probe the relationship between migrant concentration and returns to labor by extracting four different measures of wages from the "2005 Mini-Census": a measure of low-skilled wage in panel (a); a measure of high-skilled wage in panel (b); a measure of the average wage earned by rural migrants in panel (c); and a measure of the average wage earned by residents in panel (d). These measures are strongly correlated between each other and thus deliver a very similar message: Rural migrant concentration is higher where wages are higher (across the board).

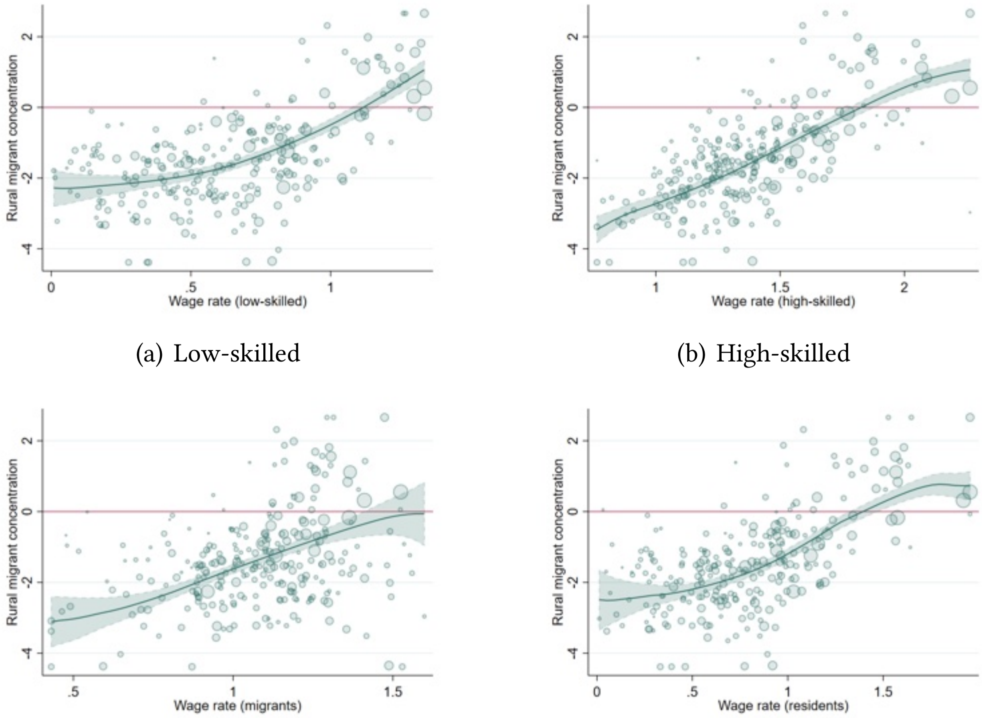
We have shown in Section 3 that rural migrants may face lower mobility costs than urban residents when they relocate *across cities*: The latter are already settled and benefit from access to services that would be lost if they were to move to other urban settings (e.g., with higher returns to labor). One corollary of this observation is that urban migrants should be less numerous and their location choices should differ quite markedly from that of rural migrants. To document this fact, we construct a measure of relative migrant concentration in city c, rm_c, as follows,

$$rm_c = m_c - \log\left(\frac{U_c/\left(\sum_c U_c\right)}{R_c/\left(\sum_c R_c\right)}\right) = \log\left(\frac{M_c/\left(\sum_c M_c\right)}{U_c/\left(\sum_c U_c\right)}\right),$$

where U_c denotes the number of urban migrants in city c having arrived between 2000

low-income workers present in Chinese cities between 2000 and 2005. Another likely explanation is a compositional effect, both in terms of available occupations and in terms of worker characteristics. For instance, migrants typically work longer hours and tend to be over-represented in these high-wage locations.

Figure B.4. Rural migrant concentration and various measures of wages.



(a) Low-skilled

(b) High-skilled

(c) Migrants

(d) Residents

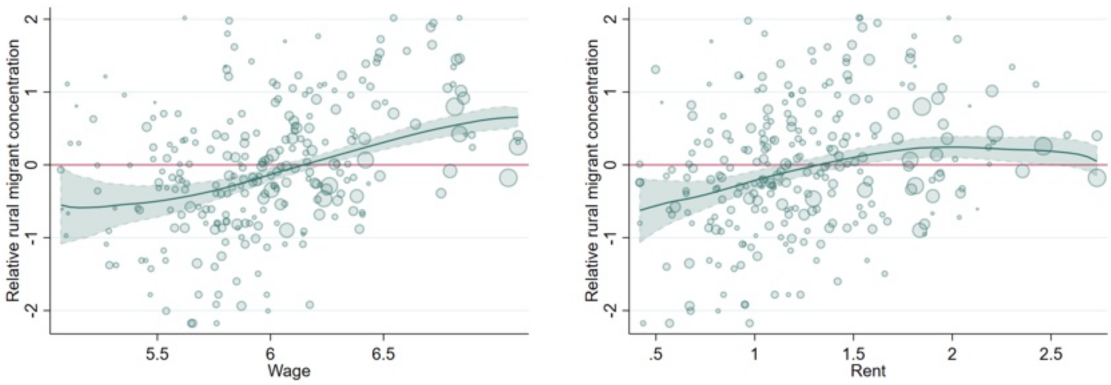
Notes: The y-axis reports the migrant concentration in city c, m_c, as defined in Section 3. The x-axis reports different measures of (log) monthly wages constructed using the "2005 Mini-Census": (i) low-skilled average wages in panel (a) based on all workers without a high-school degree; (ii) high-skilled average wages in panel (b) based on all workers with a high-school degree; (iii) migrant wages in panel (c); and (iii) resident wages in panel (d).

and 2005. This measure would be equal to 0 if migrants were allocated in the same fashion, independently of their registration type (rural or urban). In panel (a) of Figure B.5, we display the relationship between this relative concentration and nominal wages, and we find that rural migrants seem to sort into high returns to labor, and even more so than urban migrants. A percent increase in the nominal wage is associated with a 0.5 percent increase in the relative share of rural migrants. Panel (b) shows the same relationship with our measure of rents.

B.4 The selection of migrants across cities

We have shown in Section 3 that the selection of rural migrants differs from that of residents across cities subject to different living conditions. For instance, migrants are much less likely to live in decent housing conditions and with children in high-wage/rent locations. In Figure B.6, we further document the selective sorting of migrants across destinations, compared to urban residents. We find that: migrants are younger, and

Figure B.5. Relative migrant concentration and living conditions in cities.



(a) Nominal wage

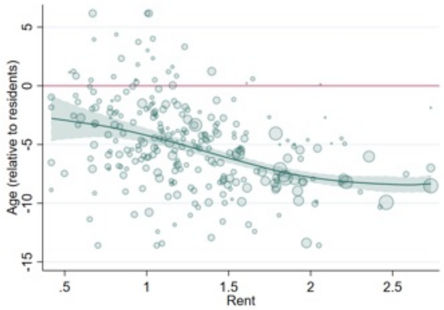
(b) Rent

Notes: The y-axis reports the relative migrant concentration in city c, rm_c. In panel (a), the x-axis reports the (log) monthly wage; in panel (b), the x-axis reports a measure of (log) rents. Rents and wages are constructed by aggregating individual responses from the 2005 1% Population Survey. A bubble is a prefecture of destination and is weighted by its initial urban population in 2000. The lines are local polynomial fits, where each observation is weighted by population.

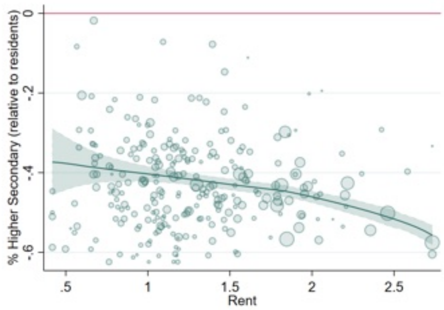
even more so in expensive locations (panel a); migrants are much less likely to have completed high school (panel b); migrants are (relatively) more likely to be males in expensive locations (panel c); and migrants are less likely to be married than residents in locations that are more expensive (panel d).

Migrants with different characteristics sort into different cities. In our main discussion (see, e.g., Section 3.2), we mostly focus on the *choice* of moving with or without family and how it interacts with location choices. We now provide a sensitivity analysis in Figure B.7. We first replace living with/without family by living with/without children in panel (a). Second, the evidence presented in Figure B.6 may threaten our main interpretation: Is the lower probability of living with family entirely explained by the fact that migrants in expensive locations are more often male and single? To test this, we focus on women who have children and consider the probability that they bring them to expensive destinations. Panel (b) of Figure B.7 shows that rural migrant mothers are as likely to live with their children as urban resident mothers in the least expensive locations, but that they are 20 percentage points less likely to bring their children in the most expensive destinations. Panel (c) shows the relative probability to live without a spouse across destinations. Panel (d) broadens the definition of family to living with any relative and shows similar patterns: Rural migrants are more likely to live without any relatives in the most expensive locations, while they are as likely as residents to live with relatives in the least expensive cities.

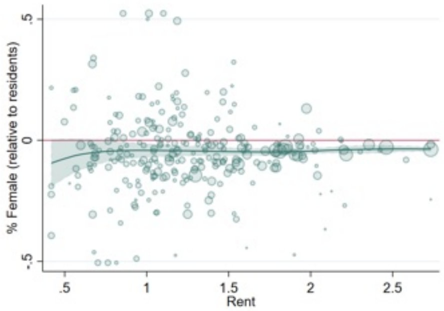
Figure B.6. The selection of migrants relative to residents in expensive cities.



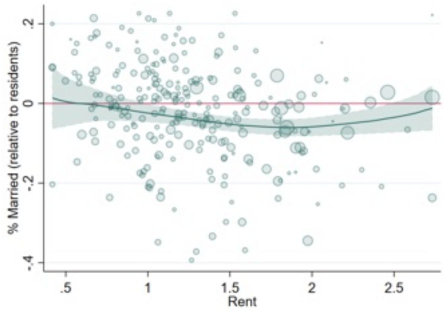
(a) Age



(b) Education



(c) Gender



(d) Marriage

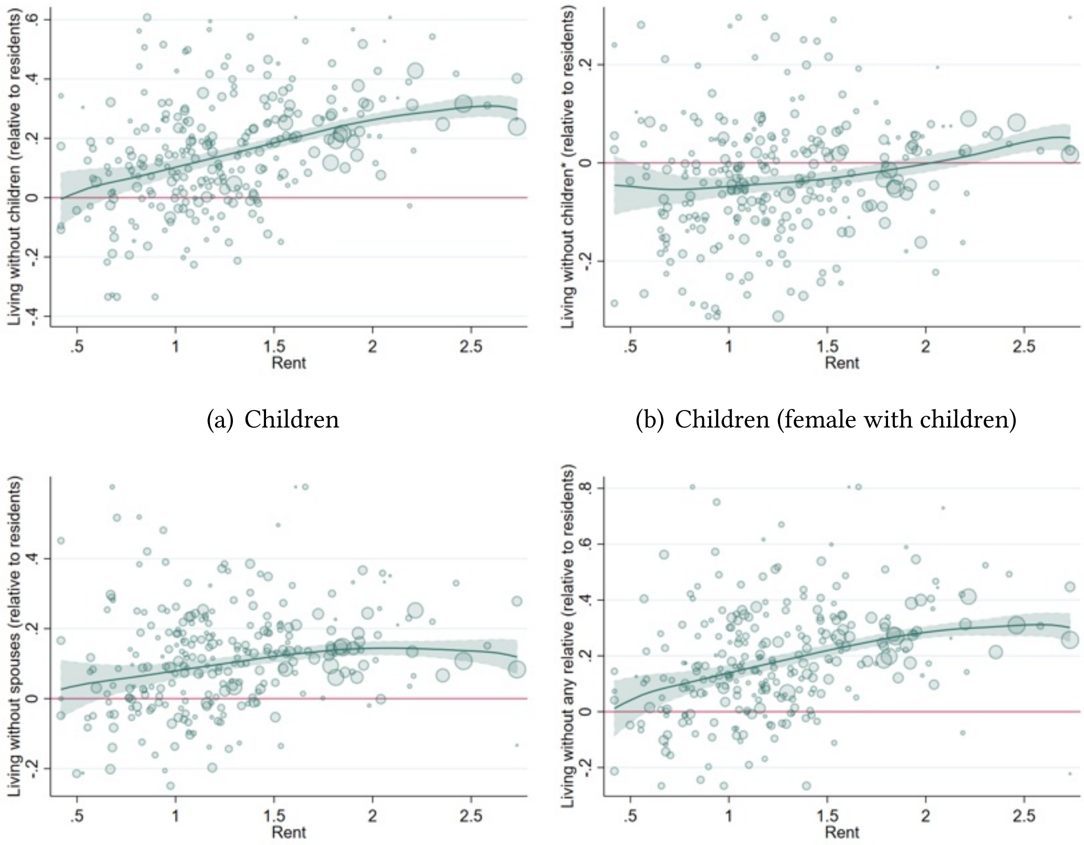
Notes: The x-axis reports a measure of (log) monthly rents constructed using the "2005 Mini-Census." In panel (a), the y-axis reports the difference between the average age of rural migrants relative to that of urban residents. In panel (b), the y-axis reports the difference between the proportion of migrants and the proportion of urban residents who have at least higher secondary education. In panel (c), the y-axis reports the difference between the fraction of migrants and the fraction of urban residents who are female. In panel (d) the y-axis reports the difference between the fraction of migrants and the fraction of urban residents who are married.

B.5 Remittances and housing expenditures

In Section 3, we document the income share spent by migrants on remittances, distinguishing migrants living with family and migrants living without. The former are found to remit less. We now provide a sensitivity analysis for this motivating fact. In Figure B.8, we display a measure of expenditures at destination for migrants living with or without family and across cheap or expensive destinations. We find that the ratio of monthly expenditures—excluding remittances—to monthly income is higher for migrants living with family and lower in more expensive locations. In fact, migrants living with family spend more on non-tradable goods at destination (see panel b).

In Figure B.9, we replicate the main Figure 5 illustrating the heterogeneity in the share of income spent on remittances at destination. While Figure 5 uses a dichotomy based on the presence of family at destination, Figure B.9 replaces this dichotomy with: the subsample of migrants living with (resp. without) children at destination in panel (a); the subsample of migrants living with (resp. without) relatives at destination in panel (b);

Figure B.7. Migrants and family—sensitivity analysis.



(a) Children

(b) Children (female with children)

(c) Spouse

(d) Relatives

Notes: The x-axis reports a measure of (log) monthly rents constructed using the “2005 Mini-Census.” In panel (a), the y-axis reports the difference between the fraction of rural migrant mothers and the fraction of urban resident mothers who live without their children; in panel (b), we restrict the sample to females declaring having children. In panel (c), the y-axis reports the difference between the fraction of rural migrants and urban residents who live without spouses. In panel (d), the y-axis reports the difference between the fraction of rural migrants and urban residents who live without any relatives. A bubble is a prefecture of destination and is weighted by its initial urban population in 2000. The lines are local polynomial fits, where each observation is weighted by population.

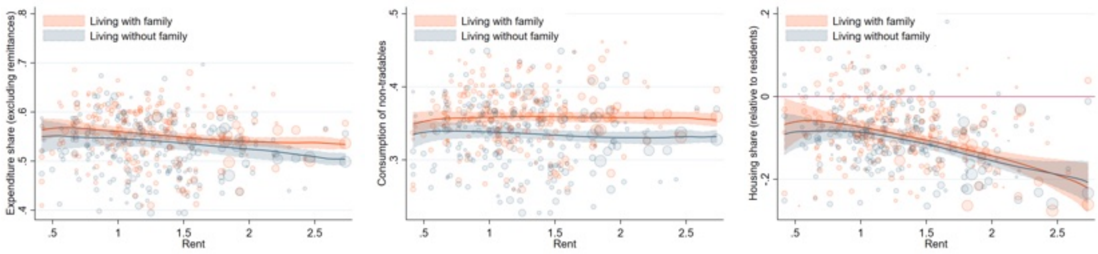
and the subsample of migrants living with (resp. without) a spouse at destination in panel (c).

B.6 The dynamics of migration arrangements across cities

Our main evidence presented in Section 3 ignores any possible dynamic adjustment of migration arrangements over the life cycle of migrants and over time. We provided some insight about the (stable) composition of migrant inflows in Appendix A.2 and Figure A.1 between 2000 and 2010. We now shed light on dynamic adjustment of migration arrangements throughout the migration spell.

Figure B.10 displays the incidence of family migration as a function of the time since

Figure B.8. Total expenditures, expenditures on non-tradable goods and housing expenditures.



(a) Expenditure share (b) Non-tradable share (c) Housing share

Notes: The x-axis reports a measure of (log) monthly rents constructed using the "2005 Mini-Census." In panel (a), the y-axis reports the average ratio of monthly expenditures—excluding remittances—to monthly income for migrants who live with their family (orange) and migrants living without family (blue). In panel (b), the y-axis reports the ratio of consumption on food and rents to monthly income for migrants who live with their family (orange) and migrants living without family (blue). In panel (c), the y-axis reports housing expenditures as a share of income for migrants who live with their family (orange) and migrants living without family (blue). A bubble is a prefecture of destination and is weighted by its initial urban population in 2000. The lines are local polynomial fits, where each observation is weighted by population.

Figure B.9. Migrants living with (orange) and without children/spouse/relatives (blue) and remittances.

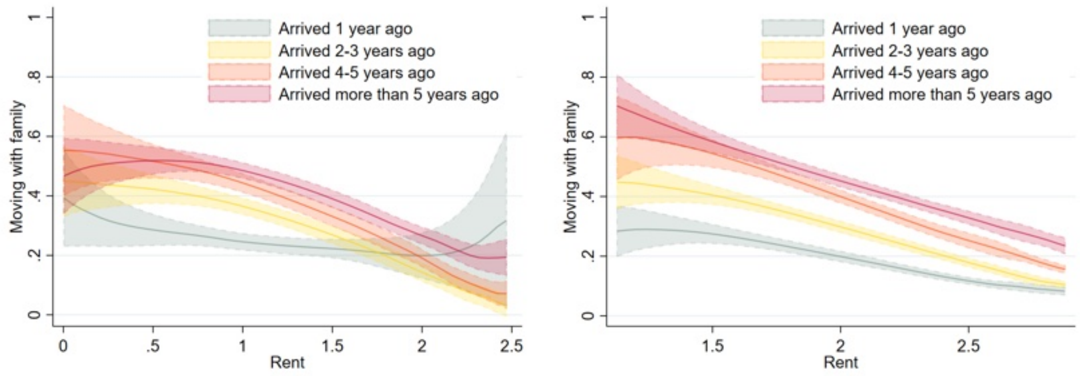
(a) Remittances (children) (b) Remittances (spouse) (c) Remittances (relatives)

Notes: The x-axis reports a measure of (log) monthly rents constructed using the "2005 Mini-Census." The y-axis reports a measure of remittances as a share of income, r_c, as extracted from CMDS (2011). The orange (resp. blue) lines and bubbles are computed from: the subsample of migrants living with (resp. without) children at destination in panel (a); the subsample of migrants living with (resp. without) relatives at destination in panel (b); and the subsample of migrants living with (resp. without) a spouse at destination in panel (c). A bubble is a prefecture of destination and is weighted by its initial urban population in 2000. The lines are local polynomial fits, where each observation is weighted by population.

arrival (at destination) in 2005 (panel a) and in 2010 (panel b). One concern could be that split migration, e.g., leaving children behind, is a temporary arrangement that does not outlive the time for migrants to accumulate resources and knowledge at destination. In short, migrants might just take longer to bring their family to expensive cities. We do not find evidence for such adjustments: If anything, time appears to matter in the least expensive cities, and the gradient of migration arrangements with prices at destination tilts even further after 4-5 years.

Figure B.11 displays the consumption patterns of migrants with and without family as a function of the time since arrival. While there is some adjustment throughout the

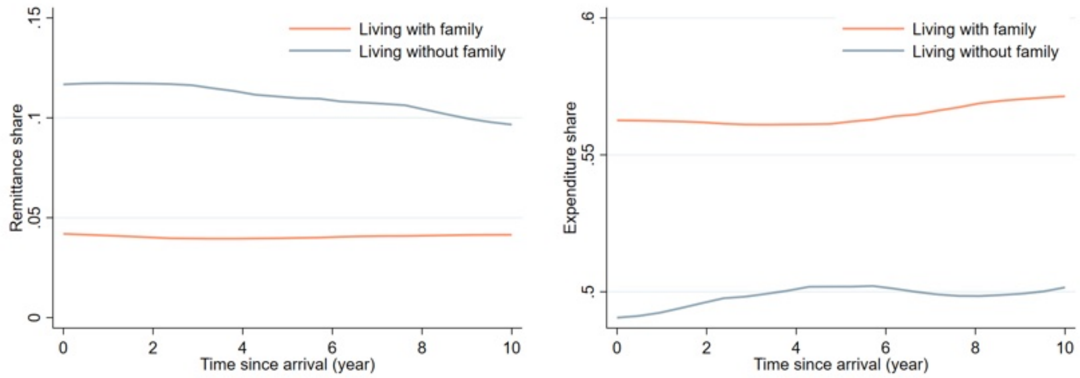
Figure B.10. Living with children throughout the migration spell.



(a) Living with children (2005) (b) Living with children (2010)

Notes: The x-axis reports a measure of (log) monthly rents constructed using the "2005 Mini-Census." The y-axis reports the share of migrants living with family at destination (in 2005 for panel a, in 2010 for panel b). The lines are local polynomial fits, where each observation is weighted by population: The green line is computed for migrants having arrived one year prior to the census (after 2004 in panel a, after 2009 in panel b); the yellow line is computed for migrants having arrived between 2 and 3 years prior to the census; the orange line is computed for migrants having arrived between 4 and 5 years prior to the census; and the red line is computed for migrants having arrived more than 5 years prior to the census.

Figure B.11. Remittances throughout the migration spell.

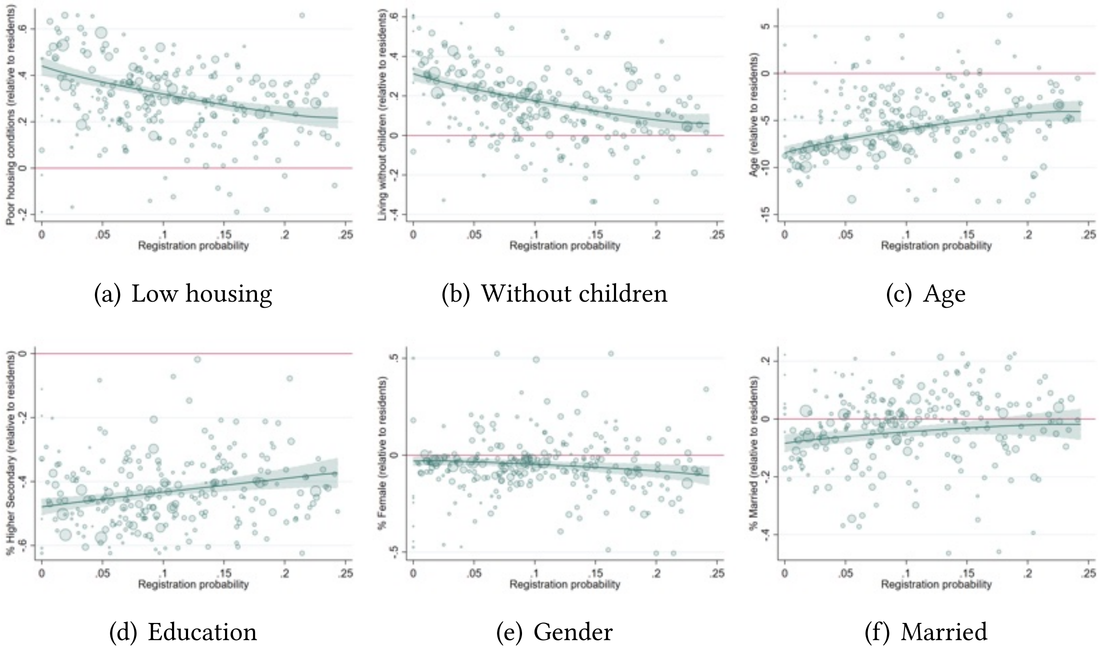


(a) Remittances (b) Expenditures

Notes: The x-axis reports the time since arrival for migrants interviewed in CMDS (2011). In panel (a), the y-axis reports the remittance share for migrants living with family at destination (orange line) and migrants living without family (blue line). In panel (b), the y-axis reports the ratio of expenditures (excluding remittances) to income for migrants living with family at destination (orange line) and migrants living without family (blue line).

migration spell, the gap between migrants with and without family remains large and stable (or converging very slowly), whether we capture it through remittance behaviors (panel a) or through consumption at destination (panel b).

Figure B.12. The selection of migrants relative to residents across cities with different local restrictions.



(a) Low housing (b) Without children (c) Age

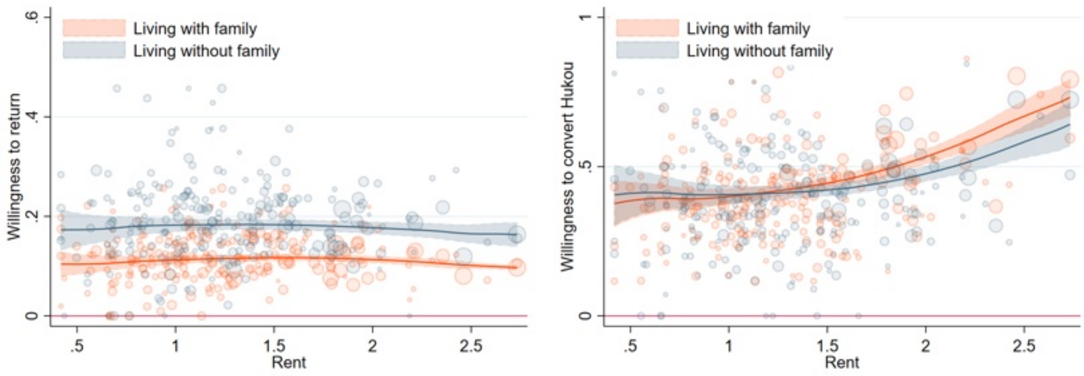
(d) Education (e) Gender (f) Married

Notes: The x-axis reports the probability for rural migrants to convert their *Hukou* registration, as computed from the 2010 Census. In panel (a), the y-axis reports the difference between the share of rural migrants and the share of urban residents who live without children. In panel (b), the y-axis reports the difference between the fraction of rural migrants and the fraction of urban residents who live in poor housing conditions, based on their dwelling characteristics measured in the "2005 Mini-Census." In panel (c), the y-axis reports the difference between the average age of rural migrants relative to that of urban residents. In panel (d), the y-axis reports the difference between the proportion of migrants and the proportion of urban residents who have at least higher secondary education. In panel (e), the y-axis reports the difference between the fraction of migrants and the fraction of urban residents who are female. In panel (f) the y-axis reports the difference between the fraction of migrants and the fraction of urban residents who are married. A bubble is a prefecture of destination and is weighted by its initial urban population in 2000. The lines are local polynomial fits, where each observation is weighted by population.

B.7 Migration patterns and *Hukou* restrictions

We provide some evidence about the selection of migrants and migration patterns across cities with different registration restrictions. To do so, we rely on our main measure of *Hukou* stringency from the 2010 Census: the share of migrants between 15 and 64 years old, who moved for work-related reasons and were born in another county, and who were registered locally with a non-agricultural *Hukou* (in the manner of Wu and You 2021). We then replicate Figure 3 and Figure B.6, but replacing the x-axis with the *Hukou* stringency measure. As apparent in panels (a) and (b) of Figure B.12, living arrangements between migrants and residents are much closer in locations where *Hukou* restrictions are milder (and the probability for rural migrants to convert their *Hukou* registration is higher). The gap in education remains however very large, irrespective of migration restrictions at destination (panel d).

Figure B.13. Future prospects across migration spells.



(a) Return migration (b) *Hukou* conversion

Notes: The x-axis reports a measure of (log) monthly rents constructed using the "2005 Mini-Census." In panel (a), the y-axis reports the average willingness to return (from CMDS) for migrants who live with their children (orange) and migrants living without children (blue). In panel (b), the y-axis reports the average willingness to convert *Hukou* to the destination location (from CMDS) for migrants who live with their children (orange) and migrants living without children (blue). A bubble is a prefecture of destination and is weighted by its initial urban population in 2000. The lines are local polynomial fits, where each observation is weighted by population.

B.8 Prospects, return migration, and *Hukou* conversion

In Figure B.13, we document the heterogeneity in prospects for migrants living across different destinations and with or without family. More specifically, we exploit questions about the willingness to return for migrants interviewed in the China Migrants Dynamic Survey (CMDS) and questions about the willingness to convert *Hukou* to the destination location (irrespective of the requirements for doing so).

We find that the share of migrants willing to go back to their origin locations is small (see panel a): About 16% of migrants living without family are willing to return versus 11% of migrants living with family at destination. About 40% of migrants are willing to have their *Hukou* converted to their destination locations, a prospect that is quite unlikely around 2000 but becomes more realistic with the gradual changes in registration policies (culminating in the 2014 reforms). This evidence rationalizes that we do not consider a dynamic model allowing, among other mechanisms, for return migration.

B.9 *Hukou* conversion and robustness to the definition of migration

Our measure of migration relies on the discrepancy between the place of household registration and the place of residence. The possibility for (some) migrants to change their *Hukou* and register at destination thus means that we mismeasure some rural-urban migrants as urban residents in the census. This measurement issue may affect the interpretation of our stylized facts. For instance, the large underrepresentation of migrants in inexpensive cities visible in Figure 2 (b) may be due to a higher *Hukou* conversion probability; in the notation of Section 3.1, identifying *Hukou* converts correctly would increase m_c (through a decline in R_c and an increase in M_c) at low levels of housing rents.

In this section, we use additional information from the 2005 and 2000 censuses to create alternative measures of migration and check the robustness of our stylized facts. Our baseline measure of migration relies on the following ingredients: (i) the discrepancy between the current place of residence and the place of household registration; (ii) information on the *Hukou* type; and (iii) information on the year of migration (within the past 5 years). *Hukou* conversion poses a challenge for this measure, as it breaks the link between migration and the first two ingredients. Conversely, (iii) is recorded for every respondent. In what follows, we leverage (iii) and complement it with data on the place of birth (in 2000) or on the place of residence 5 years before the census (as a proxy for the place of birth, which is not available in 2005).[44] Since these alternative measures of migrants' origins are recorded at the province rather than at the prefecture level, we also reproduce our main stylized facts considering only (*Hukou*-defined) migration spells across provincial boundaries.

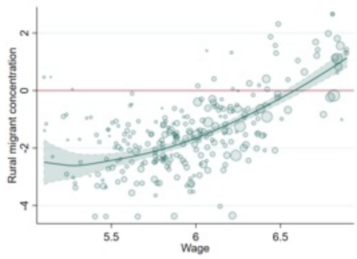
Figure B.14 reproduces Figure 2 (a) and (b), using alternative migration definitions. The alternative migration definitions vary the date at which migration flows are constructed (2005 as in the baseline, or 2000 using the 2000 census), the level at which they are constructed (prefecture-level as in the baseline, or province-level) and the way migrants are identified (*Hukou*-based definition as in the baseline, versus a birthplace-based definition of migration). Across all cases, we observe gradients nearly identical to our first stylized fact.

Similarly, Figure B.15 reproduces Figure 3 (a) and (b), respectively, using alternative migration definitions. We observe that the level and steepness of the fitted polynomials may change slightly, but our second stylized fact remains robust to the change of migration definitions.[45]

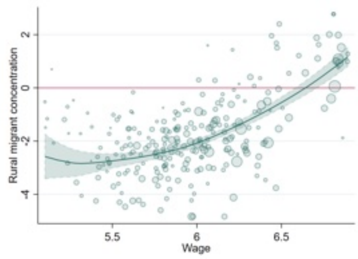
[44] The latter is an acceptable proxy of birthplace or the place of *Hukou* registration before conversion if step migration is limited. Imbert et al. (2022) show that this was indeed the case in 2000–2005 in China.

[45] Our third and fourth stylized facts rely on remittance data; such information are not available in the censuses.

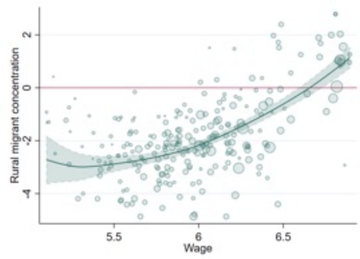
Figure B.14. Rural migrant concentration—alternative migration definitions.



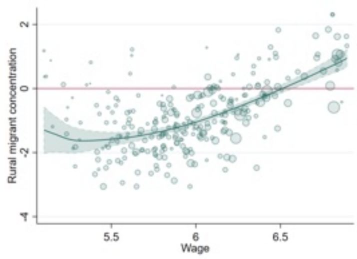
(a) Wage and migrant concentration (prefecture, *Hukou*, 2005)



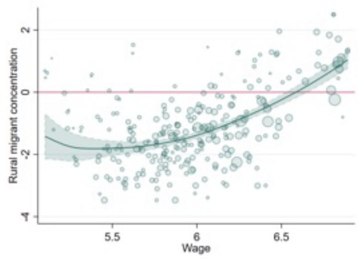
(b) Wage and migrant concentration (province, *Hukou*, 2005)



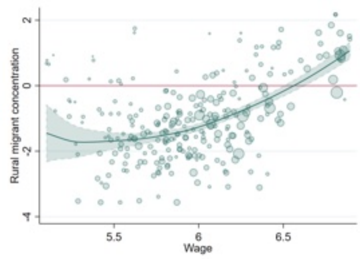
(c) Wage and migrant concentration (province, birthplace, 2005)



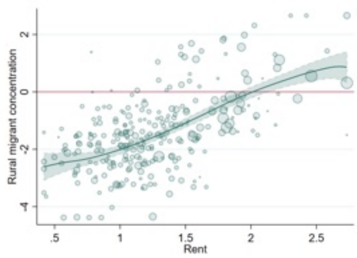
(d) Wage and migrant concentration (prefecture, *Hukou*, 2000)



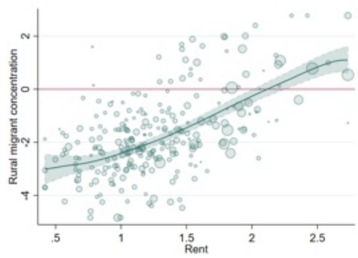
(e) Wage and migrant concentration (province, *Hukou*, 2000)



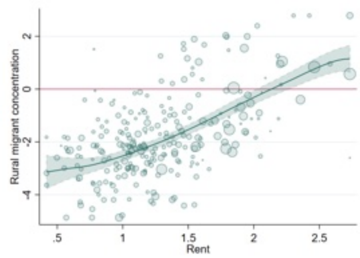
(f) Wage and migrant concentration (province, birthplace, 2000)



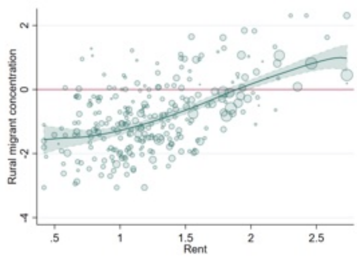
(g) Rent and migrant concentration (prefecture, *Hukou*, 2005)



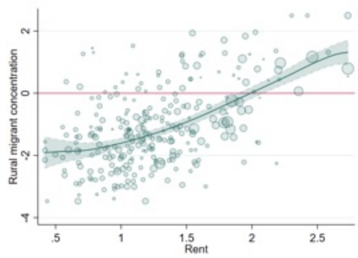
(h) Rent and migrant concentration (province, *Hukou*, 2005)



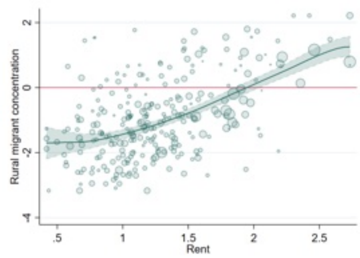
(i) Rent and migrant concentration (province, birthplace, 2005)



(j) Rent and migrant concentration (prefecture, *Hukou*, 2000)



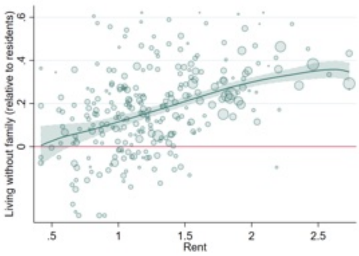
(k) Rent and migrant concentration (province, *Hukou*, 2000)



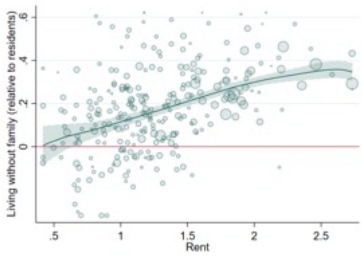
(l) Rent and migrant concentration (province, birthplace, 2000)

Notes: The y-axis reports the migrant concentration in city c, m_c—see Section 3.1. In panels (a) to (f), the x-axis reports a measure of (log) monthly wage. Wages are constructed using the "2005 Mini-Census" in 2005 or the City Statistical Yearbooks in 2000. In panels (g) to (l), the x-axis reports a measure of (log) monthly rent per square meter. Rents are constructed using the "2005 Mini-Census" in 2005 or the 2000 Census in 2000. A bubble is a prefecture of destination and is weighted by its urban population in 2000. The lines are local polynomial fits, where each observation is weighted by population.

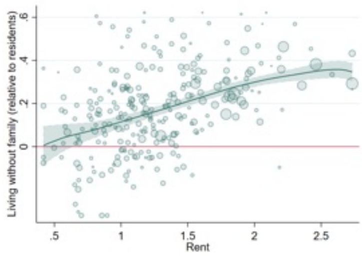
Figure B.15. Migrants, family, and housing conditions—alternative migration definitions.



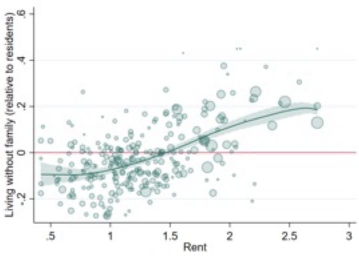
(a) Live without family (prefecture, *Hukou*, 2005)



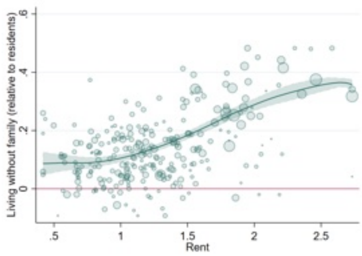
(b) Live without family (province, *Hukou*, 2005)



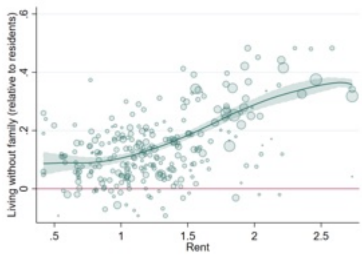
(c) Live without family (province, birthplace, 2005)



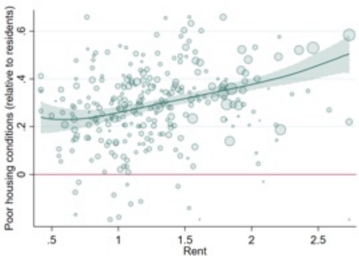
(d) Live without family (prefecture, *Hukou*, 2000)



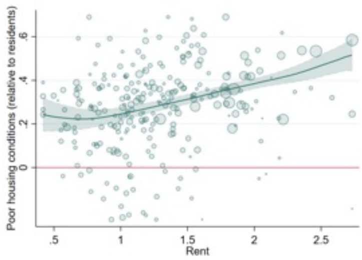
(e) Live without family (province, *Hukou*, 2000)



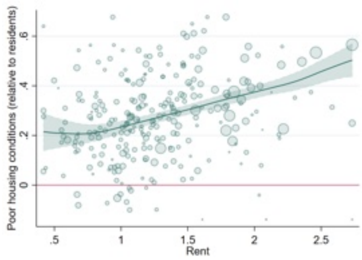
(f) Live without family (province, birthplace, 2000)



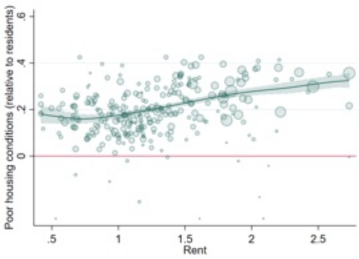
(g) Low-quality housing (prefecture, *Hukou*, 2005)



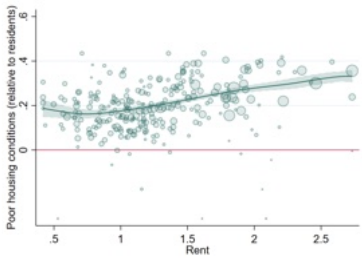
(h) Low-quality housing (prov., *Hukou*, 2005)



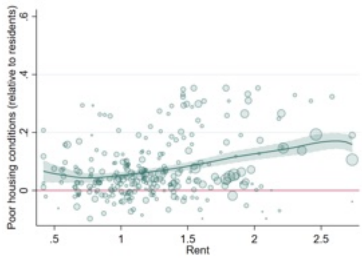
(i) Low-quality housing (province, birthplace, 2005)



(j) Low-quality housing (prefecture, *Hukou*, 2000)



(k) Low-quality housing (prov., *Hukou*, 2000)



(l) Low-quality housing (province, birthplace, 2000)

Notes: The x-axis reports a measure of (log) monthly rents constructed using the "2005 Mini-Census" (2000 Census) for the top (bottom) three panels. The y-axis reports the difference between the share of rural migrants and the share of urban residents who live without family in panels (a) to (f) and the difference between the fraction of rural migrants and the fraction of urban residents who live in poor housing conditions in panels (g) to (l). A bubble is a prefecture of destination and is weighted by its initial urban population in 2000. The lines are local polynomial fits, where each observation is weighted by population.

C Complements to the model

C.1 Model with urban to urban migration

In our baseline model, we assumed for simplicity that urban residents were immobile. In practice, there is some urban-urban migration in China, even if, as Figure 1 makes clear, it is much less important than rural-urban migration. In this section, we expand our model so that urban residents are mobile across locations, which allows us to determine the initial allocation of urban residents as a function of location fundamentals and model parameters.

The fact that there is not much urban to urban mobility around the year 2000 in China, as documented in Figure 1, probably reflects the fact that the gain from moving is much lower for urban residents than for rural ones, rather than limits to mobility. In fact, the rate of conversion to local *Hukou* is much higher among urban movers than among rural ones.

Urban to urban mobility Urban *Hukou* holders decide where to live based on the following utility function:

$$\ln U_{iu} = (1-\alpha)\ln C_T + \alpha \ln C_{NT} + \ln \varepsilon_{iu},$$

subject to standard budget constraint:

$$C_T + p_u C_{NT} \leq w_u,$$

where we use the same notation as the main text, and where we assume that $\alpha_O = 0$. In this context, utility maximization results in the following indirect utility for each individual i with origin u and destination $u' \in U$:

$$\ln V_{juu'} - \tau_{juu'} + \varepsilon_{ijuu'} = \ln w_{u'} - \alpha \ln p_{u'} - \tau_{juu'} + \varepsilon_{ijuu'}$$

This maximization problem results in the following share of workers across locations:

$$\frac{N_{juu'}}{N_{jU}} = \left(\exp(-\tau_{juu'})\frac{V_{juu'}}{V_{jU,u}}\right)^{1/\lambda_U},$$

where $\frac{N_{juu'}}{N_{jU}}$ is the probability for inhabitants of u to j-migrate to u', conditional on j-migrating to any other city in U. In this case, the marginal mover between any two urban locations is indifferent across locations, as is normal in spatial equilibrium models.

We can use this labor supply equation together with the Cobb-Douglas version of the labor demand equation to solve for the initial distribution of urban residents across locations, which, in the baseline model, we took as exogenous:

$$w_u = A_u \beta N_u^{-(1-\beta)} K_u^{1-\beta} = \tilde{A}_u N_u^{-(1-\beta)}$$

and:

$$p_u = \left(\alpha \frac{w_u}{T_u^H} N_u\right)^{\frac{1}{1+\eta_u}} = \left(\frac{\alpha}{T_u^H}\right)^{\frac{1}{1+\eta_u}} N_u^{\frac{\beta}{1+\eta_u}} = \left(\tilde{T}_u^H\right)^{-1/\alpha} N_u^{\frac{\beta}{1+\eta_u}}$$

Hence, we can substitute these two equations into V_u to obtain that:

$$V_u = Z_u \tilde{A}_u \tilde{T}_u^H N_u^{-(1-\beta)-\frac{\alpha\beta}{1+\eta_u}}$$

Hence,

$$V_U = \left[\sum_u \left[Z_u \tilde{A}_u \tilde{T}_u^H N_u^{-(1-\beta)-\frac{\alpha\beta}{1+\eta_u}}\right]^{1/\lambda_U}\right]^{\lambda_U}$$

These equations define a system of U equations and U unknowns ($N_u, \forall u \in U$) that uniquely determines the distribution of urban residents N_u as a function of fundamentals $\left\{A_u, T_u^H\right\}$ and the main elasticities of the model $\{\lambda_U, \beta, \alpha, \eta_u\}$, as formally shown in Allen and Arkolakis (2014).

Note that we can get closed-form solutions for the distribution of urban residents as a function of fundamentals when we do not have heterogeneity in the elasticity parameters. Alternatively, we can get closed-form solutions but as a function of the prices, which depend on the heterogeneous elasticities.

C.2 Model with multiple skills

In our baseline model, we assumed, for simplicity, that there is only one labor type. In practice, labor may be heterogeneous, and hence captured better with multiple factor types. We discuss here how the model changes when we think about multiple skill types.

Considering multiple skills is probably more important from the perspective of recipient locations than from sending rural communities. It is quite natural to think that, in urban locations, there are many highly qualified jobs that are different in nature than jobs that require fewer/other types of skills.

To address this simplification of our baseline model, we present here an extension with multiple types of labor that follows Amior and Manning (2021), and we investigate how this affects the local labor and housing markets.

Local production As in the main text, we assume that tradable output in location u is produced with the following production function:

$$Y_u = A_u \left[(1-\beta) K_u^{\frac{\sigma-1}{\sigma}} + \beta L_u^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}};$$

however, in this case, L_u is a labor composite of different types of workers that can be expressed as:

$$L_u = \left[\sum_e \beta_e (L_{ue})^{\frac{\sigma_e-1}{\sigma_e}}\right]^{\frac{\sigma_e}{\sigma_e-1}}.$$

As in the main text, A_u is the local (exogenous) productivity, K_u denotes capital or land, and the parameter σ denotes the elasticity of substitution between labor and the other factor.

This production function allows us to apply the results in Amior and Manning (2021). For this, we need to assume that each factor can be decomposed between urban residents and (rural) migrants as $L_{ue} = N_{ue} + M_{ue}$. We can denote the fraction of urban residents and migrants in each (e, u) cell as $\nu_{ue} = N_{ue}/N_u$ and $\mu_{ue} = M_{ue}/M_u$. Then, we can rewrite the labor aggregate as:

$$L_u = F(N_{ue} + M_{ue}, \forall e) = \left[\sum_e \beta_e(\nu_{ue}N_u + \mu_{ue}M_u)^{\frac{\sigma_e - 1}{\sigma_e}}\right]^{\frac{\sigma_e}{\sigma_e - 1}} = F(\nu_{ue}N_u + \mu_{ue}M_u) = Z(N_u, M_u)$$

In this setting, an inflow of migrants, holding the immigrant distribution across factor types fixed, results in the following:

$$\frac{\partial Z(M_u, N_u)}{\partial M_u} = \sum_e \mu_{ue} \frac{\partial F_e(N_{ue} + M_{ue}, \forall e)}{\partial M_{eu}}$$

The effect of a migrant shock will be the weighted average of the effect of migrants to each factor type. Under perfect competition in the labor market, this can be interpreted as the average effect on wages in the location.

Hence, the counterfactuals that we performed should be interpreted as holding the distribution of migrants across skill types fixed in each location.

Local housing markets Having multiple factor types also affects the housing market. With multiple skills, there are multiple wage levels. These different wage levels enter the demand for housing, which is reflected in the market clearing condition of the housing sector:

$$T_u^H(p_u)^{\eta_u} = \sum_e \frac{w_{ue}}{p_u}\left[\alpha N_{ue} + \alpha_D M_{ue}\right],$$

We can rewrite this expression as:

$$\ln p_u = \frac{1}{1+\eta_u} \ln\left[\alpha N_u\left(\sum_e w_{ue}\nu_{ue}\right) + \alpha_D M_u\left(\sum_e w_{ue}\mu_{ue}\right)\right] - \frac{1}{1+\eta_u}\ln T_u^H.$$

In turn, this expression can be re-written as:

$$\ln p_u = \frac{1}{1+\eta_u} \ln\left[\alpha N_u \bar{w}_u^N + \alpha_D M_u \bar{w}_u^M\right] - \frac{1}{1+\eta_u}\ln T_u^H.$$

This expression is very similar to the one in our baseline model, except that we now need to take into account that the average wage of urban residents and immigrants may be different because natives and immigrants may be differently distributed over factor types. However, the main intuition still applies. An immigrant inflow will increase the demand for housing, thereby putting upward pressure on housing prices. At the same time, however, the immigrant shock may affect wages in the city, which in turn, affects the demand for housing. Which of these two forces dominates is, in general, ambiguous.

In this case, the counterfactuals that we perform would need to take into account the potentially heterogeneous effect of migration on average wages of natives and immigrants separately.

D Complements to the model estimation

This section provides complements to Section 5: (a) we first describe the identification of the elasticity of substitution between consuming at origin and at destination, ρ; (b) we identify the shape parameters of the location choice model and we describe how we extract exogenous variation in the relative value of emigrating with family; and (c) we estimate the labor demand and housing supply elasticities.

D.1 A composite price index

Section 5.1 relies on the estimation of the elasticity of substitution between consuming the non-tradable good across locations. The average (log) expenditure share on remittances in city u, $\ln(\mathcal{E}_u)$, is related to local housing prices, p_u, as follows:

$$\ln(\mathcal{E}_u) = \ln\alpha + \ln\alpha_O + (\rho - 1)\ln p_u + e_u.$$

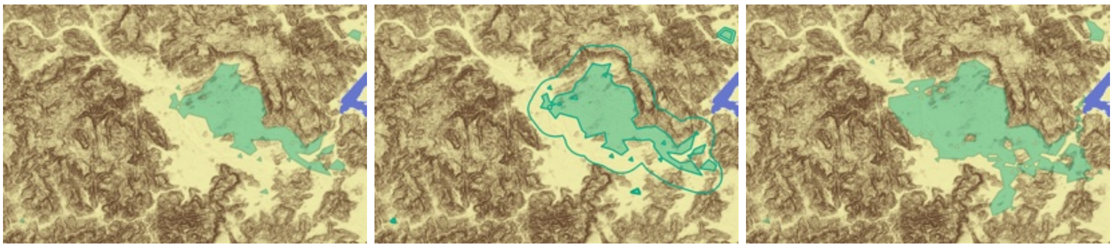
We now describe how we construct a housing-price shifter.

Exogenous variation in housing supply We exploit exogenous variation in housing supply across destinations to predict variation in the price of non-tradables (i.e., housing services). To do so, we identify the shape of cities before our episode of mass migration, and we precisely characterize topography in their immediate hinterlands.

We proceed in three steps. In a first step, we draw on the identification of impervious areas by the Beijing City Lab in 2000 to identify the urban extent of each city within a given prefecture. In a second step, we construct a city-specific buffer, the extent of which is calibrated to ensure that all cities grow proportionally, and homogeneously in all directions (Harari 2020). In a third step, we identify water coverage and the local ruggedness within this buffer of potential urban sprawl. In our baseline strategy, we calculate the share of non-developable land within this land stretch for city u, s_u, by classifying a pixel of 30m × 30m as "non-developable" if the average slope is above 5 degrees.

Figure D.1 provides insight about the construction of the instrument and the variation that it induces across urban areas. Fuzhou and Hangzhou are two historical cities. As shown in panels (a) and (d) of Figure D.1, they markedly differ in constraints to their expansion before mass migration: Fuzhou is in a valley along the Min River and is surrounded by steep hills (especially in the north), while Hangzhou is located in a plain with a few scattered hills. Fuzhou would need to build on a very large share of "non-developable" land if it were to expand in all directions and as much as the average Chinese city (panel b). Hangzhou, on the other hand, would face very limited constraints

Figure D.1. An example of our procedure with Fuzhou and Hangzhou.



(a) Fuzhou (2000) (b) Fuzhou (buffer) (c) Fuzhou (2005)

(d) Hangzhou (2000) (e) Hangzhou (buffer) (f) Hangzhou (2005)

Notes: Shapefiles of impervious areas, as identified from Landsat satellite imagery, are provided by the Beijing City Lab—see https://www.beijingcitylab.com/—and are indicated as plain green areas (2000 in panels a-b and d-e, 2005 in panels c and f). The green line in panels b and e corresponds to urban sprawl, as predicted by a uniform growth across cities and within cities across all directions.

(panel e). In 2005, we find indeed that Fuzhou experienced an unbalanced urban sprawl concentrated toward the south, while Hangzhou sprawled massively in every direction.

Table D.1. Estimates of ρ—first-stage.

	Rent (log)
Share of non-developable land	1.857
	(0.458)
Share of non-developable land × TFP	0.905
	(0.522)
Observations	199

Notes: A unit of observation is a prefecture. Robust standard errors are reported between parentheses. The specification uses population weights in 2000. The dependent variable is the (log) rent, computed using the housing module of the "2005 Mini-Census." The (log) rent is instrumented by (i) the share of developable land as induced by local geography around city borders in the baseline period (an instrument based on the work by Saiz 2010, Harari 2020) (2000-2005) and (ii) its interaction with manufacturing Total Factor Productivity in 2000 (Imbert et al. 2022). The set of controls consists of: manufacturing Total Factor Productivity in 2000, the share of developable land as induced by local geography around city borders before the baseline period (1995-2000), and (log) population in 2000.

Elasticity of substitution between consuming at origin and destination We use the previous instrument, i.e., the share of developable land at the fringe of cities, to identify the elasticity of substitution between consuming at origin and destination. We rely on the following specification where c is a city in 2005:

$$\ln(\mathcal{E}_u) = a + (\rho - 1)\ln p_u + \mathbf{X}_u\beta + e_u,$$

where $\ln(\mathcal{E}_u)$ is the average (log) expenditure share on remittances in city u and p_u is the average rent, both inferred from the "2005 Mini-Census." We use our previous geographical variation to construct two instruments: (i) s_u, the share of developable land as induced by local geography around city borders in the baseline period, and (ii) its interaction with (log) manufacturing Total Factor Productivity in 2000 (Imbert et al. 2022). The specifications reported in Table 3 thus include (log) manufacturing Total Factor Productivity in 2000 and (log) population at destination as separate controls. Table D.1 shows the first-stage estimates.

The identification assumption is that local geography at the fringe of cities only affects expenditures on housing through local housing prices, and that it does so more acutely in highly productive cities. One concern is that local geography could affect the type of housing arrangements (dorms, informal housing, etc.) and that local housing prices might be contaminated by such variation. In unreported robustness checks, we further correct for housing arrangements in the construction of local housing prices without finding any significant differences in our final estimates.

D.2 Estimation of the location choice model

The location choice model of Section 5.2 is characterized by three nests and three associated specifications.

The lower nest (λ_1, λ_2) and its gravity structure In Section 5.2, we estimate a simple model of location choice across destinations for workers migrating with and without family (see Table 4). The identification of the lower nest relies on a productivity shifter that impacts real wages at destination. This productivity shifter is constructed as follows. The National Bureau of Statistics (NBS) provides a longitudinal census of all state-owned manufacturing enterprises (SOEs) and all non-SOEs manufacturing establishments, as long as their annual sales exceed RMB 5 million. We use the NBS data to estimate total factor productivity in 2000 following Imbert et al. (2022) and based on a corrected measure of firm capital (Brandt et al. 2014). The productivity shifter is constructed as the residual of the following equation:

$$y_i = A_i f(k_i, l_i),$$

where i is a manufacturing firm and the function f is a CES production function (consistent with our present modeling of the tradable sector). We then construct a measure a_u of the average (log) productivity, $\ln A_i$, across the various manufacturing firms within a given prefecture u. In principle, this industrial shifter to labor productivity at destination is driven by persistent patterns in industrial activity across space and more likely to be orthogonal to local (unobserved) amenities.

Table D.2. The lower nest (λ_1, λ_2)—first-stage.

Value at destination	(1)	(2)
Total Factor Productivity	0.125	0.117
	(0.057)	(0.057)
Trade shock	1.940	1.895
	(0.399)	(0.392)
Migration type	$j = 1$	$j = 2$
Observations	47,906	47,550

Notes: A unit of observation is a pair of origin/destination prefectures in 2005. The specification uses population weights at origin in 2000. Standard errors are reported between parentheses and clustered at the level of origins. The dependent variable is the value at destination calculated for migrants leaving their family at origin ($j = 1$, column 1) and for migrants bringing their family at destination in columns (2) ($j = 2$). The set of controls consists of: (log) population at destination in 2000 and (log) geodesic distance between the origin and destination prefectures. The explanatory variables are manufacturing Total Factor Productivity at destination in 2000 (Imbert et al. 2022) and a trade shock computed following Facchini et al. (2019).

We provide the first-stage specification underlying the estimations of the lower nest in Table D.2. Both the productivity shifter a_u and the trade shock (Facchini et al. 2019) are strong predictors of real wages across destinations—irrespective of the manner in which real wages are computed (using a family-based composite price index, $\mathcal{P}$, or not). We obtain similar results irrespective of using either one or the other instrument, or both.

The middle nest (μ) The middle nest of our nested structure can be identified through the decision of moving with or without family, given the relative value of migrating with and without the family from each origin r, $\ln\left(V_{2U,r}/V_{1U,r}\right)$. More specifically, the relative incidence of family emigration verifies:

$$\ln\left(\frac{\pi^c_{2r}}{\pi^c_{1r}}\right) = \frac{1}{\mu}\ln\left(\frac{V_{2U,r}}{V_{1U,r}}\right),$$

where $\pi^c_{jr} = \sum_u \pi^c_{jru}$ is the emigration rate of migrants of mode j from origin r, conditional on emigrating from r. The relative value of family migration across origins r can be written as follows:

$$\ln\left(\frac{V_{2U,r}}{V_{1U,r}}\right) = \ln\left(\frac{\left[\sum_{u\in U}\left(\exp\left(-\tau_{2ru}\right)V_{2ru}\right)^{1/\lambda_2}\right]^{\lambda_2}}{\left[\sum_{u\in U}\left(\exp\left(-\tau_{1ru}\right)V_{1ru}\right)^{1/\lambda_1}\right]^{\lambda_1}}\right).$$

We use the parameters $(\rho, \alpha, \alpha_{1O}, \alpha_{2O}, \lambda_1, \lambda_2)$ and the residual migration costs (τ_{jru}) from the lower nest estimation to compute the relative value of migrating with and without the family from each origin r, $\ln\left(V_{2U,r}/V_{1U,r}\right)$. More precisely, the residual migration costs are defined in relative terms. For each rural origin r, we take one reference destination $\bar{u}$ and compute $\pi^c_{jru}/\pi^c_{jr\bar{u}} = \left[\exp(-\tau_{jru})V_{jru}/\exp(-\tau_{jr\bar{u}})V_{jr\bar{u}}\right]^{\frac{1}{\lambda_j}}$. Re-arranging yields the relative τ: $\exp(-\tau_{jru})/\exp(-\tau_{jr\bar{u}}) = \left[\pi^c_{jru}/\pi^c_{jr\bar{u}}\right]^{\lambda_j} V_{jr\bar{u}}V_{jru}$. In what follows, we simplify the notation and write $V_{2U,r}/V_{1U,r}$, although at this step of the estimation we can only reconstruct $V_{2U,r}/V_{1U,r} \times \exp(-\tau_{1r\bar{u}})/\exp(-\tau_{2r\bar{u}})$. The estimation of γ—see below—will allow us to recover the absolute τ's and V's.

We can see from the structure of these values that they interact a gravity-driven component (τ_{jru}) with a composite attractiveness of destinations for migrants with or without family (V_{jru}). Both objects are black boxes combining many different, unobservable factors. Our main strategy thus consists in keeping a gravity structure, but leveraging exogenous variation in the relative attractiveness of destinations.

The relative value of residing at destination u with or without the family might be contaminated by measurement error or by omitted variation. For instance, this value should be strongly predicted by *hukou* stringency or prices at destination. These *hukou* restrictions and prices are, however, endogenous to migration flows: Many cities implemented severe restrictions in expectation of large immigration from their rural hinterlands; and prices typically respond to migration inflows or to omitted variation affecting immigrant flows.

In a first step, we rely on exogenous variation in prices at destination that differentially affect migrants with family and without. More specifically, we create a measure of predicted wages in cities by regressing observed wages on manufacturing Total Factor Productivity at destination in 2000 (Imbert et al. 2022) and a trade shock computed following Facchini et al. (2019); we create a measure of predicted rents in cities based on the share of developable land as induced by local geography around city borders; and we combine these two prices to extract a measure of real wages, $\hat{\omega}_{ju}$, per migration mode j—accounting for differential consumption of non-tradables at destination. This first instrument is then:

$$z^1_r = \ln\frac{\sum_{u\in U}\hat{\omega}_{2u}/d_{ru}}{\sum_{u\in U}\hat{\omega}_{1u}/d_{ru}},$$

which is a gravity-weighted (d_{ru} is the distance between r and u) combination of relative real wages, as induced by exogenous variation in prices across destinations.

The second step of our approach consists in extracting a backward-looking, exogenous predictor of restrictions: the relative level of grain reserves before 2000, as in Zhang et al. (2020). The rationale goes back to Mao Zedong's conception of development, a major tenet of which was local self-sufficiency in grain. This tenet can be seen from the Great Leap Forward (1958–1960) to the Cultural Revolution (1966–1976) and partly owes to the severe constraints on the non-market allocation of resources in a poor country with limited communications and state capability (see, e.g., Riskin 1981). China, as many Communist countries, had a rigid system to allocate resources, but its low level of development put limits on how centralized this system could be, and reallocation of resources across sub-regional administrative units was kept to a minimum (Lardy 1990). The opening of the Chinese economy in the 1990s and the 2000s was expected to generate significant migration flows, which could further strain the allocation of resources. For this reason, the initial disparity in *hukou* stringency reflected the capacity of a prefecture to sustain its population without external intervention. As food provision became completely separated from household registration only in 2000, cities indeed had to maintain the agricultural capacity to nourish their population, including migrants (Cai et al. 2001).[46] We leverage this variation by considering the (log) level of grain reserves before 2000, g_u, as a predictor of *hukou* stringency.[47] We combine this variation g_u with the (baseline) migration incidence from an origin r to possible destinations u, ξ_{ru}, in a gravity structure mimicking the previous equation to construct an instrument z_r^2 for the relative value of family migration:

$$z_r^2 = \ln \sum_{u \in U} \xi_{ru} g_u,$$

following the same gravity structure exhibited by the relative value of migrating with and without the family.

We provide the first-stage specification underlying the estimations of the middle nest in Table D.3. As shown in columns (1) and (3), prices at the typical destination do predict the relative value of family migration. Local grain sufficiency in the 1990s is also a strong predictor of the relative value of family migration (see columns 2 and 3).

The upper nest (γ) The identification of the upper nest (γ) of the location model relies on the following equation:

$$\ln \left(\frac{1 - \pi_{rr}}{\pi_{rr}} \right) = \frac{1}{\gamma} \ln \left(\frac{V_{U,r}}{V_{rr}} \right).$$

[46] This policy implied huge costs from misalignment with local comparative advantage. The mark left by the Great Famine and its handling by the Central Government (Meng et al. 2015) may however have made this policy palatable to local decision makers, because of the risks of relying on outside supplies of grain.

[47] We proxy g_u with per capita grain output in 1990 from the Statistical Yearbooks.

Table D.3. The middle nest (μ)—first-stage.

Value of family migration	(1)	(2)	(3)
Exposure to high relative real wages (z_r^1)	0.125		0.117
	(0.038)		(0.039)
Exposure to grain reserves (z_r^2)		0.111	0.090
		(0.036)	(0.038)
Observations	180	180	180

Notes: A unit of observation is a prefecture. Robust standard errors are reported between parentheses. The specification uses population weights in 2000. The dependent variable is the relative value of family migration. The explanatory variables are gravity-based measures combining predicted real wages from TFP and from trade and land supply shocks, $\hat{\omega}_{ju}$ (per mode j), and based on the relative level of grain reserves before 2000, g_u. In column (1), the instrument is z_r^1; in column (2), the instrument is $z_r^2 = \sum_{u \in U} g_u \xi_{ru}$; and we include both instruments, z_r^1 and z_r^2, in column (3). The set of controls consists of: dummies for each quintile in the level of grain reserves within the prefecture before 2000, the yield for staple crops within the prefecture, the local level of wages and rents, the manufacturing Total Factor Productivity at destination in 2000 (Imbert et al. 2022), a trade shock computed following Facchini et al. (2019), and a local price shock as induced by international crop prices (Imbert et al. 2022).

We consider the following empirical counterpart:

$$\ln\left(\frac{1-\pi_{rr}}{\pi_{rr}}\right) = a + b\ln\left(\frac{V_{U,r}}{V_{rr}}\right) + \varepsilon_r,$$

where $V_{U,r}$ is the value of migrating from location r:

$$\ln V_{U,r} = \ln\left[\sum_{j\in\{1,2\}} \left(V_{jU,r}\right)^{1/\mu}\right]^{\mu},$$

and V_{rr} is the real wage in origin location r:

$$\ln V_{rr} = \ln w_r - \alpha \ln p_r.$$

Constructing V_{rr} is straightforward, but the construction of the value $V_{U,r}$ is more involved and relies on the estimates of μ, $V_{1U,r}$ and $V_{2U,r}$ from the estimation of the middle nest. Recall that we were only able to recover $V_{jU,r}/\exp(-\tau_{jr\bar{u}})$ from this earlier step. We now consider migration without family as a reference and note that:

$$\frac{\pi^c_{2rU}}{\pi^c_{1rU}} = \left(\frac{V_{2U,r}}{V_{1U,r}}\right)^{\frac{1}{\mu}}.$$

Using this equation, we can recover:

$$\frac{V_{2U,r}}{\exp(-\tau_{1r\bar{u}})} = \left(\frac{\pi^c_{2rU}}{\pi^c_{1rU}}\right)^{\mu} \times \frac{V_{1U,r}}{\exp(-\tau_{1r\bar{u}})},$$

which we use to compute:

$$\frac{V_{U,r}}{\exp(-\tau_{1r\bar{u}})} = \left[\sum_{j\in\{1,2\}} \left(\frac{V_{jU,r}}{\exp(-\tau_{1r\bar{u}})} \right)^{1/\mu} \right]^{\mu}.$$

We will denote the previous quantity as $V_{U,r}$ for the time being, noting once again that only the estimation of γ will allow us to recover all the τ's and the V's—see below.

We instrument the relative value, $V_{U,r}/V_{rr}$, with exogenous shocks to agricultural productivity across possible origins by combining international commodity prices with local cropping patterns (in the manner of Imbert et al. 2022). We first collect Agricultural Producer Prices data (APP, 1991–2016) from the FAO: The data report producer prices at the farm gate in each producing country. For any given crop, we aggregate these country-specific prices into a yearly, international producer price as a weighted average across countries using the baseline share in crop-specific exports as the country/crop weight.[48] We then clean these (log) international producer prices from long-run trends by applying a HP filter (see Imbert et al. 2022) and isolating the residual, d_{ct}, for any given year t and commodity c.

Table D.4. The upper nest (γ)—first-stage.

Relative value of emigration	(1)	(2)
Agricultural revenue shock	-9.877	-10.022
	(1.677)	(2.128)
Observations	186	186
Controls	No	Yes

Notes: A unit of observation is a prefecture. Robust standard errors are reported between parentheses. The specification uses population weights at origin in 2000. The dependent variable is the relative value of emigration. The set of additional controls consists of: dummies for each quintile in the level of grain reserves within the prefecture before 2000, the manufacturing Total Factor Productivity within the prefecture in 2000 (Imbert et al. 2022), a trade shock computed following Facchini et al. (2019), and the share of developable land as induced by local geography around city borders. The agricultural revenue shock interacts cropping patterns in 2000 with the HP-filtered prices of agricultural commodities in 2000 (as in Imbert et al. 2022).

These international commodity prices affect agricultural hinterlands differently, depending on local cropping patterns. We exploit this intuition and combine international

[48]We focus on the following 21 crops (commodities): banana, cassava, coffee, cotton, fodder crops (barley), groundnut, maize, millet, other cereals (oats), potato, pulses (lentil), rapeseed, rice, sorghum, soybean, sugar beet, sugar cane, sunflower, vegetables (cabbage), tea, and wheat. The international price of these commodities is disciplined by World demand and World supply, and China is a large World supplier for a few crops. The most obvious one is tobacco, where China is the leading producer and one company enjoys a local monopoly; we thus exclude tobacco from our agricultural productivity measures.

prices with the revenue share of crop c at origin r in a shift-share design. More specifically, we need the following ingredients to construct a revenue share for each crop: (i) a measure of output (e.g., as measured in tonnes) across locations; and (ii) a price per tonne. We construct a measure of output by multiplying local harvested areas in 2000 (a measure "in acres") with a local predicted yield (a measure "in quantity per acre"). The harvested areas are provided by the World Census of Agriculture 2000 and the predicted yield is constructed within the Global Agro-Ecological Zones project. Nesting these measures within Chinese prefectures requires some geographic approximation that is best described in Imbert et al. (2022). We weight this predicted output in 2000 by the baseline commodity price in 1980 to construct a revenue share for each crop, α_{cr}, which is orthogonal to later deviations in international prices. Letting d_c denote the previous price residual at a period of interest, our agricultural productivity shock, ω_r, will be defined as:

$$\omega_r = \sum_c \alpha_{cr} \times d_c.$$

The estimates reported in Table 6 rely on a two-stage specification where we instrument the real wage w_r with ω_r. We provide the first-stage specification underlying the estimations of the upper nest in Table D.4. The agricultural revenue shock from Imbert et al. (2022) is a strong predictor of the relative value of migrating across origins ($\frac{V_{U,r}}{V_{rr}}$).

Finally, using the estimated parameter γ, we can compute,

$$\exp(-\tau_{1r\bar{u}}) = [(1-\pi_{rr})/\pi_{rr}]^{\gamma} \times \exp(-\tau_{1r\bar{u}})/V_{U,r} \times V_{rr},$$

and reconstruct the (absolute) migration frictions, τ_{jru}, which we use in our mapping of Section 5.4 and our counterfactual exercises of Section 6. Based on these τ's, we can also recalculate the "true" value functions, and re-estimate the middle and the upper nests. The estimates of μ and γ are virtually unchanged.

D.3 Labor demand and housing supply at destination

The identification of the production block of the model requires exogenous variation in migrant inflows to estimate their effect at destination. The previously-described, exogenous variation in local conditions at origin ω_r allows us to predict emigration from a certain location into a particular destination.

We leverage these agricultural revenue shocks (ω_r) to isolate exogenous variation in immigrant flows across the destinations following the shift-share procedure developed in Imbert et al. (2022). More specifically, we combine exogenous shocks to rural incomes in each prefecture of origin (shifts) with a gravity matrix based on distance between each

Table D.5. Labor demand and housing supply elasticities—first-stage.

Immigration rate	(1)	(2)
Shocks at the typical origin	-1.324	-0.864
	(0.267)	(0.170)
Observations	216	252

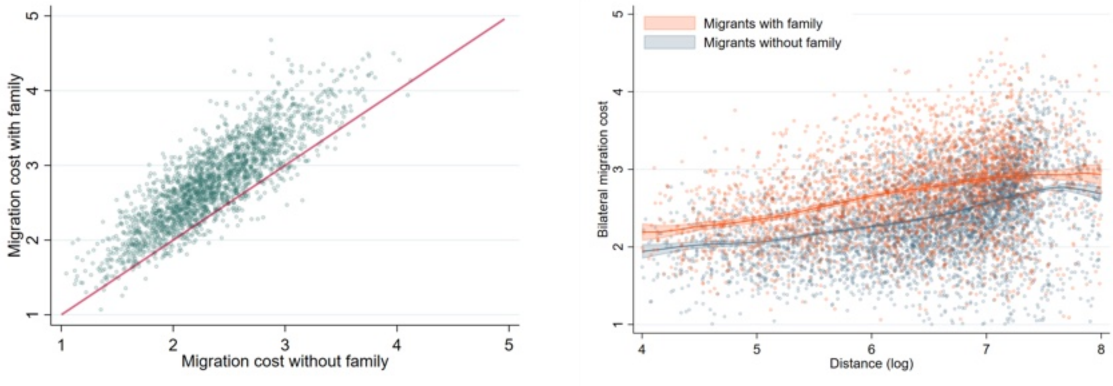
Notes: A unit of observation is a prefecture. Robust standard errors are reported between parentheses. The specification uses population weights at origin in 2000. The dependent variable is the immigration rate between 2000 and 2005, computed using the migration module of the "2005 Mini-Census." The set of baseline controls consists of: (log) population in 2000 and the agricultural shocks at the typical origin associated with the prefecture before the period of interest (1995-2000). We add the following controls in column (1): the manufacturing Total Factor Productivity at destination in 2000 (Imbert et al. 2022), and a trade shock computed following Facchini et al. (2019). We add the following controls in column (2): the (log) migrant population in 2000, the share of developable land as induced by local geography around city borders before the baseline period (an instrument based on the work by Saiz 2010, Harari 2020, see Appendix D.1), and their interaction. The instrument exploits agricultural shocks between 2000–2005 at the typical origin associated with the prefecture (as in Imbert et al. 2022).

origin and each potential prefecture of destinations (shares):

$$z_u = \sum_{r \in R} \left(\frac{1}{d_{ru}} \right) \omega_r,$$

relying on the same gravity structure exploited in Appendix D.2 but nested across destinations (rather than origins). We report the first-stage estimates in Table D.5.

Figure D.2. Bilateral migration costs and distance.



(a) Overall distribution

(b) Geographic distance

Notes: Panel (a) plots the bilateral migration costs for family migration (y-axis, τ_{2ru}) against the bilateral migration costs for non-family migration (x-axis, τ_{1ru}). Panel (b) plots these bilateral migration costs against the (log) distance between origin r and destination u. The lines are local polynomial fits.

D.4 A decomposition of migration costs

This section provides complements to Section 5.4. More specifically, we shed light on the variation underlying our inferred migration frictions, $\left\{\tau_{jru}\right\}_{j,r,u}$, most notably their relationship with observable characteristics, e.g., distance between origins and destinations or disamenities at destination such as pollution or urban sprawl/commuting costs.

We first shed light on the distribution of bilateral migration costs for family migration (τ_{2ru}) and non-family migration (τ_{1ru}) in panel (a) of Figure D.2 and their relationship with (log) distance between origins and destinations in panel (b). We find that migration systematically induces higher costs for family spells than for non-family ones, and such costs are markedly higher when destinations are distant from origins (panel b). These findings reflect the relatively low incidence of family migration and the observed geographic gravity in movements across Chinese prefectures.[49]

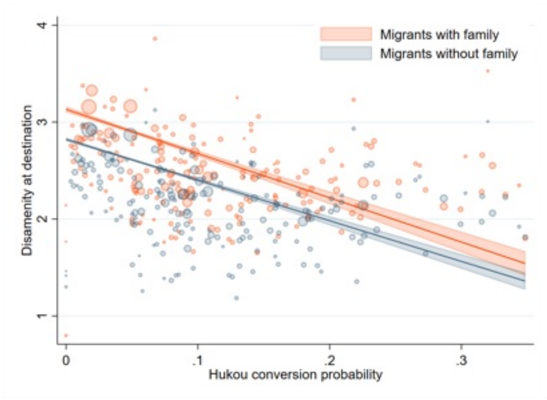
We then illustrate the relationship between migration policies and migration barriers in Figure D.3, where we plot the average disamenity, τ_{ju}, for family ($j = 2$) versus non-family migrants ($j = 1$) against two alternative measures of *hukou* stringency or leniency: the share of migrants who had converted their *hukou* registration place to the local prefecture in 2010, and the composite *hukou* stringency index developed by Zhang et al. (2018).[50] Figure D.3 shows that our estimated migration frictions negatively correlate with the likelihood of converting *hukou* registration at destination (panel a), and such a negative correlation is observed both for family- (τ_{2u}) and for single-specific migration frictions (τ_{1u}). The gradient is however more pronounced for the former: While the average disamenity is much higher for family migrants in destinations where *hukou* conversion is unlikely, the average disamenity for family migrants gets closer to that of non-family migrants in destinations where *hukou* conversion is likely, as we documented with causal estimates in Table 8. The same gradients can be observed for another measure of *hukou* leniency (or stringency in this case, see panel b), and also when the share

[49]Our estimates of migration costs are comparable to those of Bryan and Morten (2019) and Tombe and Zhu (2019). It is worth noting two things. First, Tombe and Zhu (2019) do not take into account the 0s in the migration matrix when estimating the elasticity of substitution across destinations. This attenuates the estimates of $1/\lambda$ which mechanically leads to higher estimates of migration costs. Second, when reporting average migration costs (as these two papers do), it is also important to think about the role of 0s. The model interprets zero migration flows between an origin and a destination as infinite migration costs (or as costs that equal to 100 percent of the wage at destination). Hence, whether the data set has more or less 0s, which may be related to data collection rather than true migration costs, has a strong influence on reported average migration costs. This explains why we do not emphasize the level of our estimates as much as its heterogeneity.

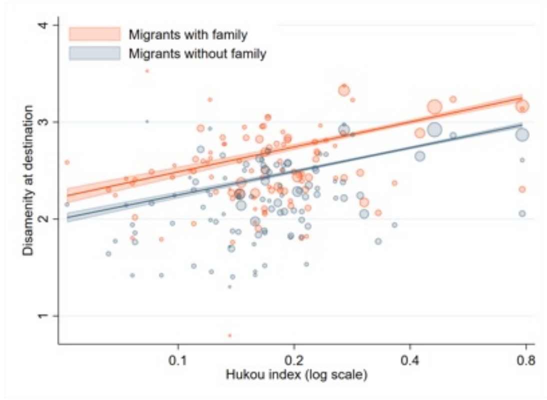
[50]In this exercise, we consider the following projection of bilateral migration costs onto an origin-destination component (τ_{ru}), a destination-mode component (τ_{ju}), and an origin-mode component (τ_{jr}):

$$\tau_{jru} = \tau_{ru} + \tau_{jr} + \tau_{ju} + \varepsilon_{jru}.$$

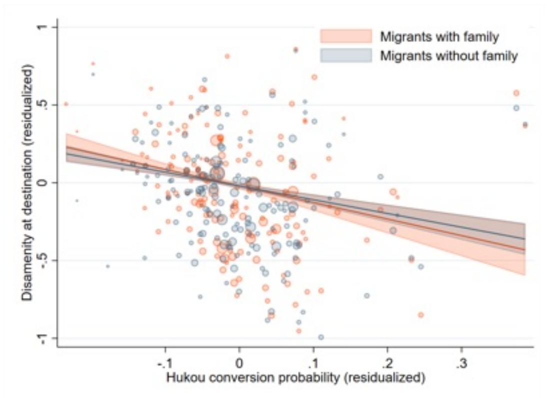
Figure D.3. Relative cost of family migration and *hukou* stringency.



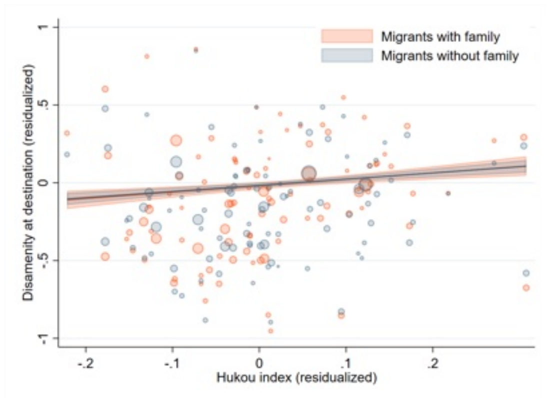
(a) Conversion probability, r_u



(b) *Hukou* index, $h_{u,a}$



(c) Conversion probability, r_u (res.)



(d) *Hukou* index, $h_{u,a}$ (res.)

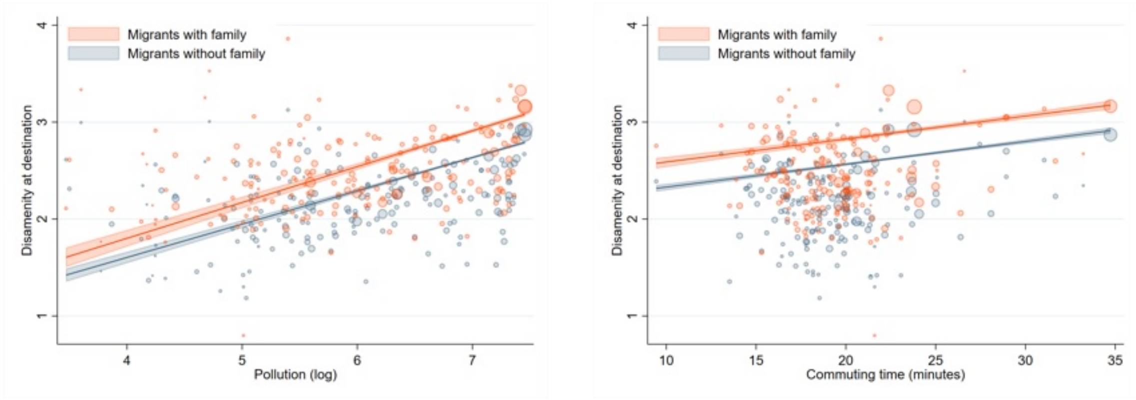
Notes: This Figure plots the correlation between the average disamenity estimates, τ_{ju}, for family ($j = 2$) versus non-family migrants ($j = 1$) across destinations against two alternative measures of *hukou* stringency: the share of migrants having converted their *hukou* in 2010 in panel (a); the composite *hukou* stringency index developed by Zhang et al. (2018) in panel (b); the residualized share of migrants having converted their *hukou* registration place to the local prefecture in 2010, r_u (panel c); and the residualized *hukou* stringency index developed by Zhang et al. (2018), $h_{u,a}$ (panel d). The residualized measures are obtained by regressing them on local population in 2000, local pollution, and commuting time.

of migrants having converted their *hukou* registration place to the local prefecture in 2010 or the *hukou* stringency index developed by Zhang et al. (2018) are residualized for observable amenities at destination, e.g., pollution and commuting (panels c and d).

In Figure D.4, we complement the previous evidence by plotting the relationship between the average disamenities and measures of pollution (panel a) and commuting time (panel b). We find that higher levels of pollution and longer commutes are both associated with higher perceived barriers at destination for both migration modes.

Finally, we display in Figure D.5 a validation of our bilateral migration estimates. By construction, these estimates—combined with the other estimates of the nested location model—should allow us to match migration flows between all origins and destinations of the largest connected set (Abowd et al. 1999, Card et al. 2013, Buggle et al. 2022).

Figure D.4. Relative cost of family migration and observable amenities.

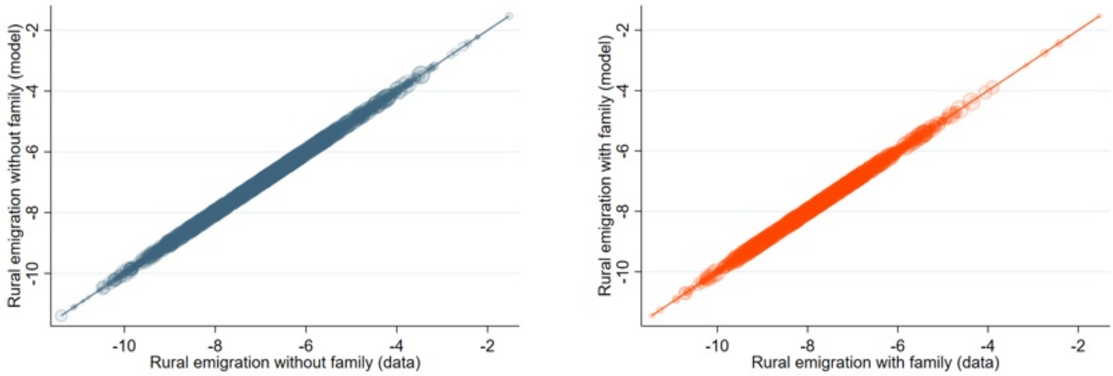


(a) Pollution

(b) Commuting time

Notes: This Figure plots the correlation between the average disamenity estimates, τ_{ju}, for family ($j = 2$) versus non-family migrants ($j = 1$) across destinations against: (log) pollution (2001–2005), commuting time (from the "2015 Mini-Census").

Figure D.5. Bilateral migration costs—matching migration flows.



(a) Without family (τ_{1ru})

(b) With family (τ_{1ru})

Notes: Panel (a) plots the predicted non-family migration induced by bilateral migration costs (τ_{1ru}) against the actual migration rates. Panel (b) plots the predicted family migration induced by bilateral migration costs (τ_{2ru}) against the actual migration rates.

Figure D.5 shows that our inferred migration barriers indeed allow us to match exactly migration incidences from all origins to all destinations. We perform the same sanity checks for all alternative models described in Section 6.3 and Appendix E.3.

E The role of displaced consumption and frictions in shaping migration

This Appendix provides complements to our counterfactual exercises discussed in Section 6. The analysis is summarized in Section 6.3 and proceeds in three steps. In a first step, we explore the normative implications of displaced consumption and migration frictions with a focus on their redistributive effects. In a second step, we consider simple extensions of our baseline quantitative model to allow for agglomeration and congestion externalities. In a third step, we illustrate the quantitative and qualitative insights induced by our precise modeling of migration and consumption choices. In settings with large differences in living standards across space, the incentives for households to migrate with or without family and split their consumption between origin and destination are instrumental in explaining migration flows. Ignoring them leads to a misspecification of bilateral migration frictions.

E.1 Normative implications and redistributive effects

We highlight the redistributive effects of displaced consumption and migration frictions by discussing: (i) additional evidence about the impact of our counterfactual exercises on wages, rents, and remittances; (ii) distributional effects across cities and across space; (iii) redistributive welfare effects between urban-born and rural-born households; and (iv) an analysis of welfare effects in general versus partial equilibrium for urban-born and rural-born households.

Wages, rents, and remittances In Sections 6.1 and 6.2, we present the effects of our counterfactual experiments on migration patterns in China and on the aggregate welfare of rural-born and urban-born households. In Table E.1, we further report their effect on wages and rents at destination and on the amount that is remitted from urban locations to rural origins. One can see that wages and rents respond to immigration flows in similar (yet opposite!) fashion. However, the wage effect is the one explaining most of the welfare response of urban-born households to migration for a straightforward reason: Rents only represent a small fraction of expenditures (about 0.28) such that a decrease of 1.5% of nominal wage has a much larger impact on real wage than an increase of 1.2% in rents. Table E.1 also sheds light on the compositional effect of migration flows on remittances. For instance, counterfactual experiments (2a) and (2b) respectively induce a more than doubling of migration flows and a slight, yet significant, increase in such flows. The response of remittances is however muted for two reasons: (i) the migration increase is disproportionately explained by family migration, which typically generates smaller shares of remittances from each migrant household; and (ii) migration lowers

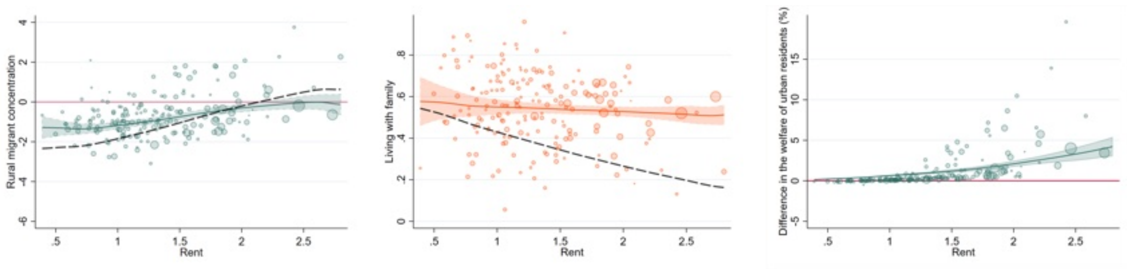
Table E.1. The role of migration frictions in shaping migration—complements.

	Urban wage (% rel. base.)	Urban rent (% rel. base.)	Remittances (% rel. base.)
		1. Shutting down remittances	
Counterfactual (1)	1.273	-1.047	-100.00
		2. The role of migration frictions	
Counterfactual (2a)	-1.509	1.241	97.78
Counterfactual (2b)	-0.195	0.160	2.64
		3. The 2014 reform and a policy evaluation	
Counterfactual (3)	-0.053	0.043	-15.55

Notes: This Table reports additional statistics on the consequences of migration flows in counterfactual experiments (1), (2a), (2b), and (3). Across all experiments, we report the differences implied by the experiment—relatively to the baseline, and in percentage points—on: urban wage in column 1, the urban rent in column 2, and the level of remittances by migrants of all types from all urban destinations to all origins (column 3).

wages at destination.[51]

Figure E.1. The role of migration frictions in shaping migration—shutting down remittances.



(a) Migrant concentration (1) (b) Living with family (1) (c) Welfare of natives (1)

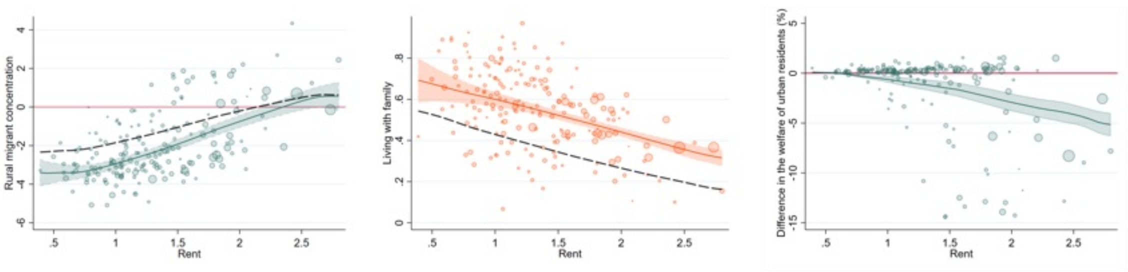
Notes: This Figure reports statistics on the extent, nature, and consequences of migration flows in counterfactual experiment (1). More specifically, we display: the concentration of migrants across cities (counterfactual in green, baseline as the dashed line) in panel (a); the incidence of family migration (counterfactual in orange, baseline as the dashed line) in panel (b); and the differences in the welfare of urban-born households relative to the baseline in panel (c).

Distributional effects across space We provide additional evidence on the distributional effects of our counterfactual experiments in Figures E.1 (counterfactual 1), E.2 (counterfactuals 2a and 2b), and E.4 (counterfactual 3). More specifically, we display the

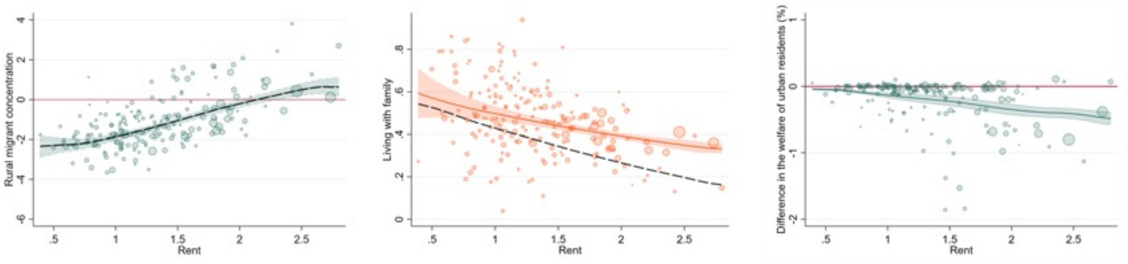
[51] Migration also increases rents at destination, thus inducing more substitution from the consumption of non-tradable goods in cities to consumption in rural origins.

concentration of migrants across cities (as in Figure 2), the incidence of family migration (as in Figure 3), and the differences in the welfare of urban-born households relative to the baseline across cities. In all figures, as in our main stylized facts, we differentiate cities using the actual level of rents in 2005. Figure E.1 illustrates that shutting down remittances reduces migrant concentration toward large, expensive agglomerations (panel a), and flattens the dependence of family migration on prices at destination (panel b). In other words, removing the possibility for migrants to displace their consumption leads to (much) fewer of them moving to expensive cities without their family. This experiment thus leads to moderate welfare gains for urban-born households in the most attractive (and expensive) cities.

Figure E.2. The role of migration frictions in shaping migration—relaxing *hukou* restrictions.



(a) Migrant concentration (2a) (b) Living with family (2a) (c) Welfare of natives (2a)

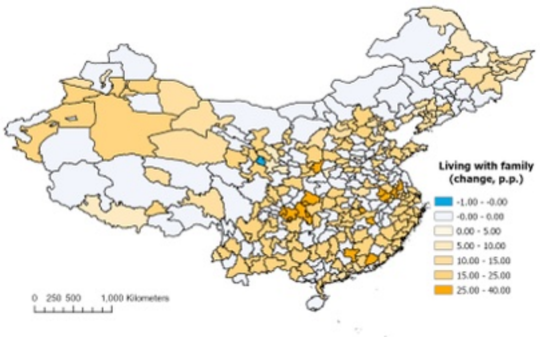


(d) Migrant concentration (2b) (e) Living with family (2b) (f) Welfare of natives (2b)

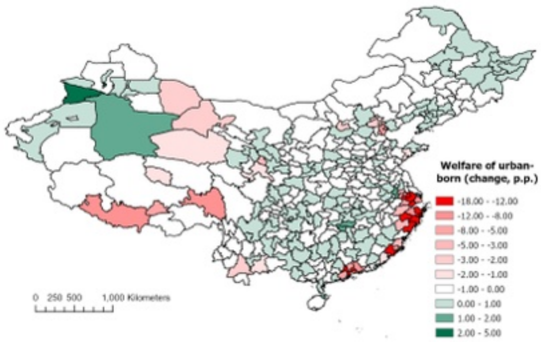
Notes: This Figure reports statistics on the extent, nature, and consequences of migration flows in counterfactual experiments (2a) and (2b). More specifically, we display: the concentration of migrants across cities (counterfactual in green, baseline as the dashed line) in panels (a) and (d); the incidence of family migration (counterfactual in orange, baseline as the dashed line) in panels (b) and (e); and the differences in the welfare of urban-born households relative to the baseline in panels (c) and (f).

Figure E.2 illustrates the distributional effect of the removal of migration barriers across cities. We see that counterfactual experiment (2a) further concentrates migrant flows toward large expensive cities, but in parallel with an upward shift of family migration across *all* cities. In other words, many more migrants move to those attractive, expensive locations that were protected by tough restrictions, either with their family or leaving relatives behind. In proportional terms, however, more migrants now move with their family. The main losers are urban-born households in attractive cities, with welfare losses of up to 5%. The distributional effect of counterfactual experiment (2b), which removes the family penalty of migrant restrictions (thus leaving restrictions for others unaffected), contrasts with that of such a general relaxation. Migration concentration across cities does not vary much relative to the baseline, but the specific concentration of the different migration modes changes: More migrants move to attractive, expensive locations with their family. Welfare losses for urban-born households are limited, even in attractive locations.

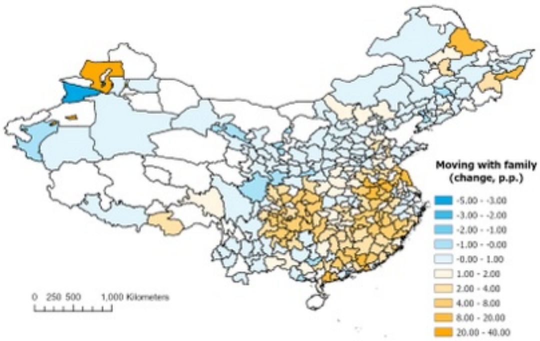
Figure E.3. Removing barriers to family migration (2a)—variation across destinations and origins.



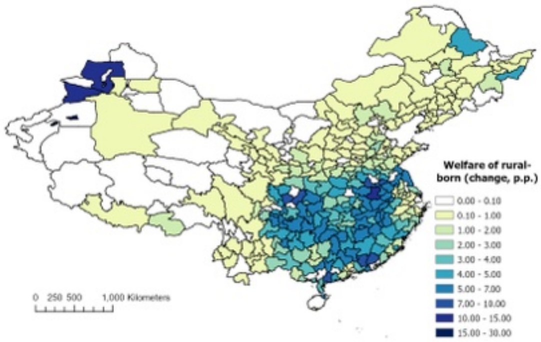
(a) Living with family



(b) Welfare of urban-born



(c) Moving with family

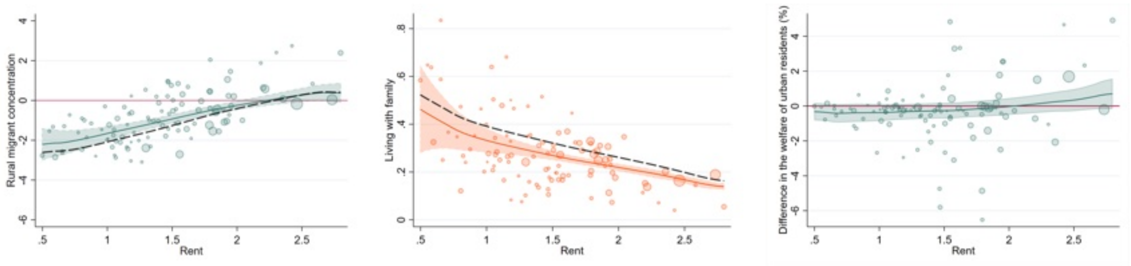


(d) Welfare of rural-born

Notes: Panel (a) displays the change in the incidence of family migration at destination as induced by the counterfactual that removes barriers to family migration (in percentage points, relative to the initial urban population in 2000). Panel (b) displays the change in the welfare of urban-born households (in percentage points). Panel (c) displays the change in the incidence of family emigration across origins. Panel (d) displays the change in the welfare of rural-born households (in percentage points) across origins.

We shed further light on the impact of counterfactual experiment (2a) and its redistributive welfare effects in Figure E.3. In panels (a) and (b), we nest those effects across destinations and report the change in the number of migrants living with family and the welfare effect of the experiment on urban-born households. We find that many more migrants would live with their family at destination and across many such destinations (as already observed in panel b of Figure E.2). The negative welfare effect of the experiment would however be concentrated toward a few urban centers: the large cities (Beijing, Shanghai); and the new exporting regions (Shenzhen/Guangzhou, Fujian, Zhejiang). Indeed, prefectures of the Northeast and of interior provinces, where *hukou* policies are the most lenient and where productivity is lower, would not experience additional migration, contrary to the productive coastal prefectures with the toughest stance on (family) immigration. In panels (c) and (d), we nest those effects across origins and report the change in the number of migrants leaving family behind and the welfare effect of the experiment on rural-born households. We find that fewer rural migrants of the "hinterlands" of the highly productive coastal prefectures would leave family behind (panel c), and there would be very significant average welfare effects for rural households in those locations (panel d).

Figure E.4. The role of migration frictions in shaping migration—the 2014 reform.



(a) Migrant concentration (3) (b) Living with family (3) (c) Welfare of natives (3)

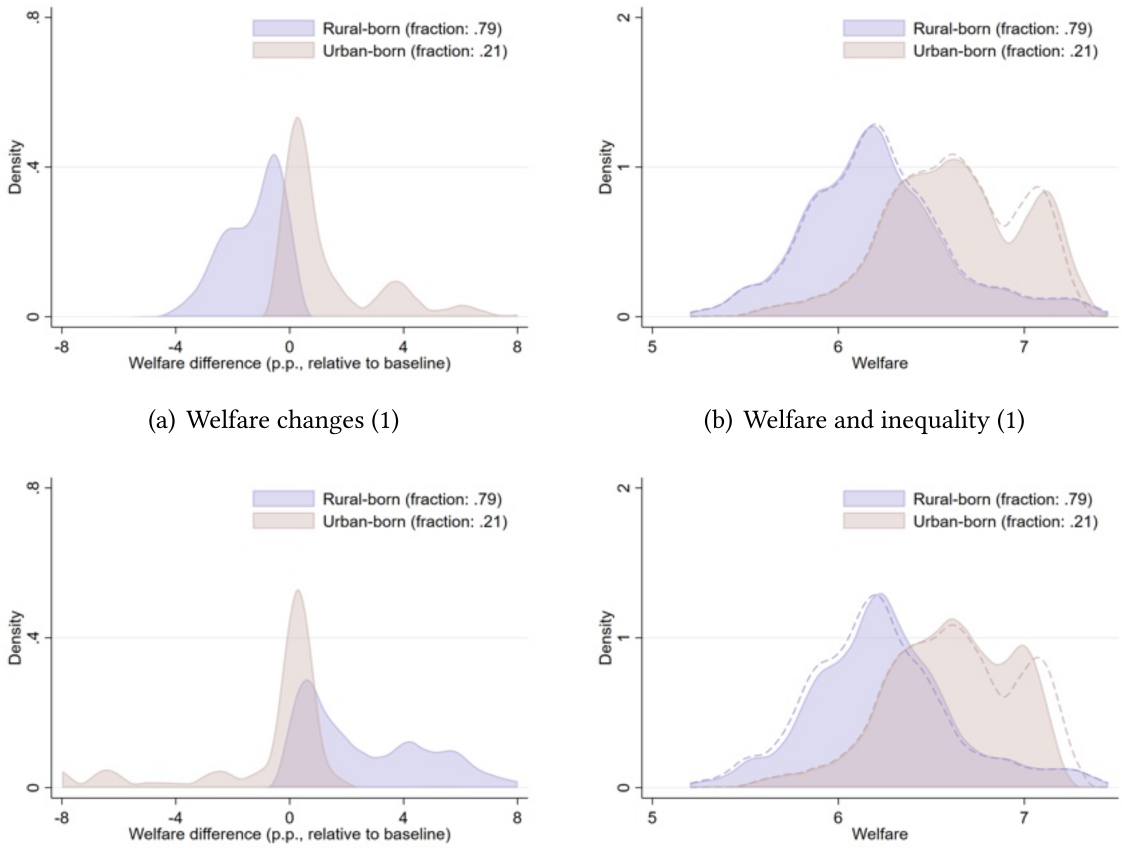
Notes: This Figure reports statistics on the extent, nature, and consequences of migration flows in counterfactual experiment (3). More specifically, we display: the concentration of migrants across cities (counterfactual in green, baseline as the dashed line) in panel (a); the incidence of family migration (counterfactual in orange, baseline as the dashed line) in panel (b); and the differences in the welfare of urban-born households relative to the baseline in panel (c).

Finally, Figure E.4 provides the same evidence for counterfactual experiment (3) mimicking the 2014 reform. Panel (c) of Figure E.4, in particular, illustrates the distributional effects of the reform, leading to a migration outflow from large cities toward smaller cities—thus inducing mirroring welfare gains/losses for urban residents.

Welfare and inequalities The previous section sheds some light onto the distributional effects of migration restrictions across space. We now discuss the redistributive effects of such policies between rural- and urban-born households, and within these two categories. Migration restrictions in China may indeed protect an urban middle class at the expense of poorer households living in rural regions, thereby limiting social mobility and consolidating income inequalities.

We provide some evidence about the normative implications of our main policies—counterfactual (1) shutting down remittances, discussed in Section 6.1, and counterfac-

Figure E.5. The role of migration frictions in shaping migration—welfare and inequality.



(a) Welfare changes (1)

(b) Welfare and inequality (1)

(c) Welfare changes (2a)

(d) Welfare and inequality (2a)

Notes: This Figure displays the welfare effects of our main policies: counterfactual (1) shutting down remittances, in panels (a) and (b); and counterfactual (2a) removing migration restrictions, in panels (c) and (d). The left panels report the differences in the welfare of urban-born and rural born households in percentage points relative to the baseline. Given our assumptions, those differences can be interpreted as (log) units of equivalent real wage. In other words, a one percentage point difference is equivalent to a change in real wage of 1%. The right panels show instead the levels of welfare in the counterfactual experiments versus the baseline (as a dashed line). Finally, we report the fraction of rural-born versus urban-bron households in the legend of these different sub-figures.

tual (2a) removing migration restrictions, discussed in Section 6.2—in Figure E.5. Panel (a) shows that the possibility for potential migrants to remit favors rural-born households, or reciprocally, a counterfactual economy where consumption would be confined to destinations would induce welfare gains for urban-born households at the expense of rural-born households. We see that the welfare gains for urban dwellers are dispersed, reflecting the wide heterogeneity in attractiveness across possible destinations: The main winners would be urban-born households in booming, expensive cities. By contrast, the welfare losses for rural households are less dispersed—reflecting the possibility for those households to choose among many destinations and the gravity structure of migration flows. More specifically, households living in the proximity of expensive cities are most affected by such an experiment, while households living far from any attractive cities are far less impacted. However, even the most affected households might still be able to mitigate the effect of the policy through a swap across migration modes and/or destinations. Panel (b) displays the levels of indirect utility for rural-born and urban-born households in the baseline (dashed lines) and in counterfactual (1). We see that counterfactual (1): exacerbates inequalities between urban-born and rural-born households; widens the welfare differences within urban-born households; and slightly reduces the welfare differences across rural-born households. Indeed, the lucky urban households born in attractive cities are even better off than before, when the relatively lucky rural households born in the hinterlands of such cities are worse off.

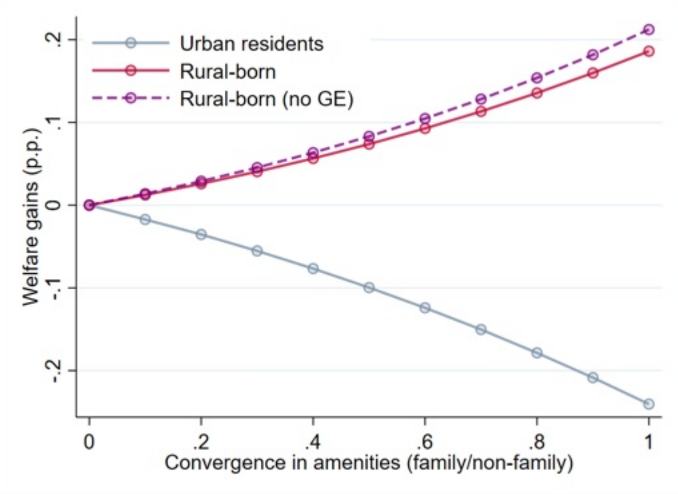
Removing migration restrictions also induces very significant redistributive effects, as illustrated in panels (c) and (d) of Figure E.5. A few destinations would receive many more migrants, thus markedly affecting the welfare of their registered inhabitants. The removal of migration barriers would however generate moderate gains for a very large number of rural-born households, the extent of which would depend on the location of rural areas compared to the most attractive destinations. The large mass of rural households in China's interior provinces would gain between 3 and 7% in equivalent real wage from this relaxation of *hukou* restrictions—see Figure E.3, panel (d). In conclusion, this relaxation would be a progressive policy, in the sense that it would reduce the gap between rural- and urban-born households and partly bridge welfare differences among the latter group.

Welfare effects of relaxing family restrictions and general equilibrium Our quantitative model of location choice is in general equilibrium, allowing economic conditions to adjust across locations and feeding them back into the complicated problem of possible migrants. To shed light on the implications of general equilibrium effects on urban- versus rural-born households, we consider the following experiment. We model the effect of a family-friendly policy that gradually bridges the gap between perceived restrictions across migration modes:

$$\tau'_{2ru} = (1 - x)(\tau_{2ru} - \tau_{1ru}) + x\tau_{1ru}.$$

for $x \in \{0, 0.1, \ldots, 1\}$. When $x = 0$, we are in the baseline and family migration induces additional barriers. When $x = 1$, the average migrant faces similar barriers (the ones without family), irrespective of the migration mode. For each x, we simulate the new allocation of migrants across space, the welfare gains of rural-born households, and the welfare losses of urban-born households. We do so for two scenarios: one in which

Figure E.6. Illustrating the welfare effects of relaxing family restrictions.



Notes: This Figure illustrates the welfare effects of the following experiment. We model the effect of a family-friendly policy that only removes the family-specific restrictions at destination, i.e., we consider:

$$\tau'_{2ru} = (1 - x)(\tau_{2ru} - \tau_{1ru}) + x\tau_{1ru}.$$

for $x \in \{0, 0.1, \dots, 1\}$. The red curve shows the welfare gains for rural-born households. The blue curve displays the welfare losses for urban-born households. The purple, dashed line shows the welfare gains for rural-born households, absent general equilibrium effects through the adjustments of labor and housing markets at destination.

economic conditions adjust, and one in which they do not.[52]

Figure E.6 shows the welfare changes induced by the previous experiment when x goes gradually from 0 to 1. For instance, when half of the gap between perceived restrictions across migration modes is bridged, the welfare of rural-born households increases by 8% and the welfare of urban-born households decreases by about 10%, an effect entirely driven by the adjustments of labor and housing markets at destination. The purple, dashed line shows instead the welfare gains for rural-born households, absent general equilibrium effects. The difference with the actual welfare gains is then an order of magnitude smaller than that felt by urban-born households. In other words, absent general equilibrium effects, rural-born households would be better off, but by not much. The reason lies in the high substitutability across migration destinations (see Table 4) and across migration modes (see Table 5): Potential migrants are always able to trade off various options and mitigate the endogenous deterioration of living standards across targeted locations. Allowing urban-born resident mobility (see Appendix C.1) would enable such trading off and thus reduce the welfare deterioration they experience when *hukou* restrictions are lifted; in this sense, the estimated counterfactual decline in urban-born

[52]Note that urban-born households can only be affected by the experiment through an adjustment of economic conditions. Accordingly, the partial equilibrium welfare effects for them are nil, irrespective of the parameter x.

household welfare constitutes an upper bound.

E.2 Introducing externalities

Our quantitative model does not feature any agglomeration externalities or other congestion forces than the ones operating through the adjustment of labor and housing markets across locations. In this section, we show how agglomeration spillovers and congestion externalities at destination would affect (i) the allocation of rural-urban migrants across space and (ii) the normative implications of a relaxation of migration policies.

We consider our baseline model, as estimated in Section 5, and add the following features across four alternative models and three sources of externalities: (i) constant and size-varying production externalities in cities, e.g., $A_u = \mathcal{A}_u L_u^{0.05}$, where L_u is labor and $\mathcal{A}_u$ is an exogenous productivity shifter in urban location u, as standard in quantitative models of urban economics (see, e.g., Ahlfeldt et al. 2015); (ii) negative congestion externalities arising from urban sprawl or pollution (see, e.g., Khanna et al. 2021), i.e., $Z_u = \mathcal{Z}_u L_u^{-0.025}$, where $\mathcal{Z}_u$ is an exogenous amenity shifter; and (iii) positive externalities from remittances at origin, i.e., $A_r = \mathcal{A}_r R_r^{0.05}$, where R_r are the level of remittances received in rural location r (conveying the idea that remittances can be used as productive investment, see Pan and Sun 2022, Khanna et al. 2022).

Table E.2 shows that the addition of productive spillovers (sometimes called agglomeration economies) further boosts the effect of relaxing migration restrictions with a larger number of migrants moving to cities with or without family than in the baseline model. The effect remains, however, limited: The first panel of Table E.2 predicts an additional inflow of about 2 million rural-born households. Adding positive agglomeration externalities implies that rural-born households are left better off from the relaxation of restrictions than estimated through our externality-free model and urban-born households are less worse off—both effects being driven by a muted response of wages to migration flows. Negative congestion externalities have the exact opposite effect: The migration response to the policy is lower, and its normative implications are less positive. More specifically, urban-born households lose more from the relaxation of restrictions when rural-born households gain slightly less. Finally, assuming that remittances boost production at origin changes our predictions in the most significant manner: While this spillover increases the social returns to migration, these returns are not internalized by migrants such that the increase in local wages mitigates the desire to move toward urban destinations. In such a model, migrants would respond *less* positively to a relaxation policy, even though the policy would have much larger welfare effects. Their muted response implies that the level of remittances would be lower than that predicted by the externality-free model. In the presence of such externalities, a social planner would be tempted to subsidize migration rather than penalize it.

Table E.2. The role of migration frictions in shaping migration—counterfactual experiments.

	Migrant households (millions)				Welfare, wages, price and remittances (% rel. baseline)				
	All	No fam.	Fam.	Fam. sh.	Rural	Urban	Wage	Rent	Remit.
Baseline	27,29	22,27	5,02	0.184	-	-	-	-	-
	1.573			*-0.160*		-			
Baseline experiment (2a)	58,10	40,64	17,46	0.301	2.740	-1.868	-1.509	1.241	97.78
	2.123			*-0.160*		*-3.191*			
1. Agglomeration spillovers									
With productive spillovers (cons.)	59.84	41.94	17.90	0.299	2.900	-1.542	-1.170	1.288	107.1
	2.142			*-0.162*		*-2.634*			
With productive spillovers (var.)	59.91	42.04	17.87	0.298	2.910	-1.551	-1.181	1.283	107.2
	2.140			*-0.162*		*-2.676*			
2. Negative spillovers on amenities									
With negative externalities	57.62	40.27	17.35	0.301	2.690	-1.951	-1.494	1.228	96.63
	2.118			*-0.160*		*-3.356*			
3. Spillovers from remittances at origin									
With remittance spillovers	52.95	37.09	15.86	0.299	6.720	-1.532	-1.238	1.018	82.37
	2.125			*-0.162*		*-2.719*			

Notes: This Table reports statistics on the extent, nature, and consequences of migration flows in the baseline and in counterfactual experiment (2a) across five alternative models: the baseline model, a model with agglomeration spillovers, a model with size-dependent agglomeration spillovers, a model with negative externalities on amenities at destination, and a model with positive productive spillovers at origin as induced by the level of remittances. Across all experiments, we report: the number of migrant households (overall in column 1, without family in column 2, with family in column 3, all reported in millions of migrant households between 2000 and 2005); the share of migrants living with family in column 4; the welfare of rural-born households in column 5 (in % relative to the baseline); the welfare of urban-born households in column 6 (in % relative to the baseline); urban wage in column 7 (in % relative to the baseline); urban rent in column 8 (in % relative to the baseline); and the level of remittances by migrants of all types from all urban destinations to all origins (column 9, in % relative to the baseline). We also report the following additional quantities in italics: (i) the elasticity of migrant concentration to the rent at destination in column 1; (ii) the semi-elasticity of family migration to the rent at destination in column 4; and (iii) the semi-elasticity of welfare gains/losses (relative to the baseline) to the rent at destination in column 6. These quantities allow us to measure migrant concentration, family migration, and urban winners/losers across cities.

E.3 Sensitivity analysis and alternative migration models

Our quantitative model of location choice is designed to best capture the choice of rural residents in transforming economies with large productivity and price differentials across urban areas and an even wider rural-urban gap. In those settings, rural migrants often consume at origin to mitigate the living costs at destination, and an important adjustment margin is whether to leave relatives behind or not (as we document in Section 3). For these reasons, we add the following ingredients to the standard migration models (see, for instance, Bryan and Morten 2019, Tombe and Zhu 2019, Monras 2020): (i) a three-nest structure for the location choice model allowing potential migrants to trade off whether to migrate or not, how to do so (with or without family), and where to go; and (ii) a technology to displace part of the consumption of non-tradable goods to origins, depending on the migration mode (with or without family).

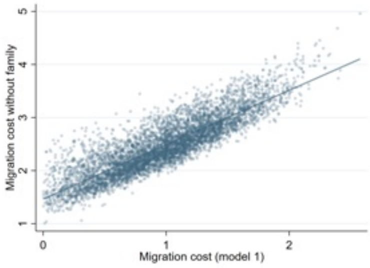
In this section, we illustrate the quantitative and qualitative insights gained through the adoption of those two novel features. To do so, we estimate four alternative models: (1) a simple model of location choice among numerous alternatives, and where the birth location is one of those alternatives (Bryan and Morten 2019, Tombe and Zhu 2019); (2) a two-nest structure with the upper nest capturing the decision to migrate or not, and the lower nest modeling the choice of destinations (Monras 2020); (3) a two-nest structure adding the possibility for migrants to displace part of their consumption (Albert and Monras 2022); and (4) a three-nest structure akin to our baseline model (i.e., with two migration modes and two associated technologies for the consumption of non-tradable goods), but where there is limited substitutability between migration modes.[53]

We estimate these models using a similar approach as in Section 5. We thus estimate Model 1 by assuming a standard formulation for real wages, i.e., $\ln(w_u/p_u^{\alpha})$, and estimating the parameter λ in a similar manner as in Table 4 (but with a slightly different explanatory variable). We estimate Model 2 by assuming the same standard formulation for real wages, i.e., $\ln(w_u/p_u^{\alpha})$, estimating the parameter λ in a similar manner as in Table 4, and estimating the parameter γ in a similar manner as in Table 6. Model 3 follows the same estimation as Model 2, except for the computation of real wages. We then account for remittances as in the baseline model, but we use an average remittance share irrespective of the migration mode. The estimation of Model 4 follows the exact steps of our baseline model, except that we impose $1/\mu = 0.4$.

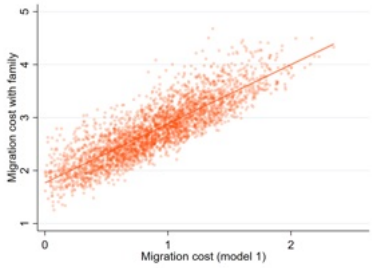
In Figure E.7, we show the correlation between our baseline bilateral costs against the estimated costs in alternative models. Overall, we find that our estimated bilateral costs for family migration are never closely matched by any of these alternative models,

[53] We impose that $1/\mu$ is one order of magnitude smaller than in our baseline estimation (see Table 5): We set $1/\mu = 0.4$.

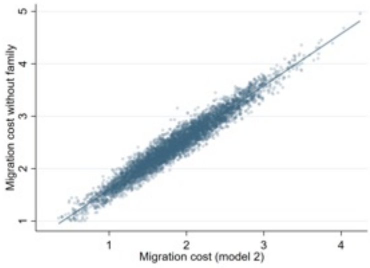
Figure E.7. Correlation between migration frictions across models.



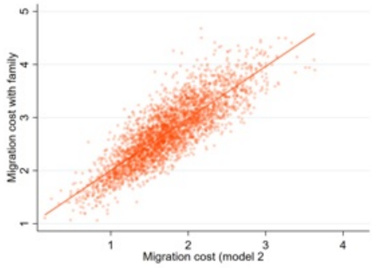
(a) Migration without family (M1)



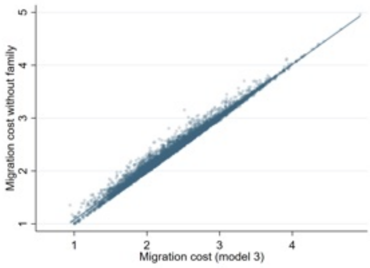
(b) Migration with family (M1)



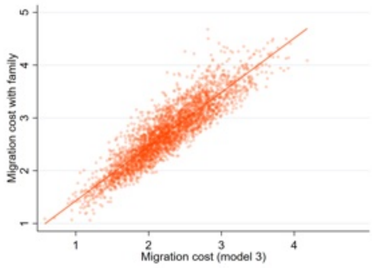
(c) Migration without family (M2)



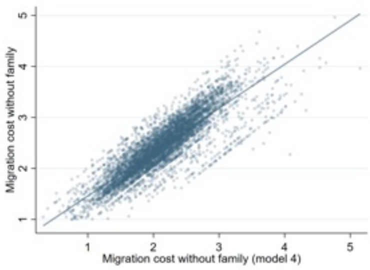
(d) Migration with family (M2)



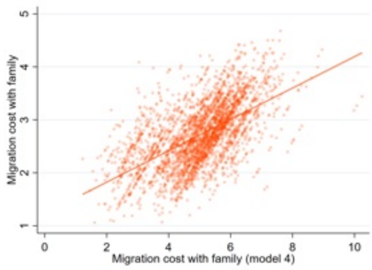
(e) Migration without family (M3)



(f) Migration with family (M3)



(g) Migration without family (M4)



(h) Migration with family (M4)

Notes: Model 1 has only one nest and one elasticity λ. Model 2 has two nests: the upper nest between migrating or staying and the lower nest across destinations for households who decide to emigrate. The previous models assume away heterogeneity in family migration (or not), and construct real wages across destinations without allowing for displaced consumption. Model 3 is similar to Model 2, except that real wages are calculated using the average remittance share. Model 4 is designed and estimated like our baseline model (three nests allowing for two migration modes and different remittance behaviors), except for one component: we shut down the substitution across migration modes by imposing that $1/\mu = 0.4$.

even Model 4. In fact, Model 4 displays wide departures from our baseline model for both types of bilateral costs because it partly loads positive variation in one mode onto a negative variation in the other mode. The bilateral costs for migration without family are more closely matched by other models. In particular, the average migration costs of Model 3 are very close to our bilateral costs for migration without family, in part because this is the dominant migration mode in the baseline.

One crucial element of such migration models—including our baseline model—is to nest all residual, unexplained variation in migration flows onto bilateral migration costs. This set of inferred parameters, labeled $\left\{\tau_{jru}\right\}_{j,r,u}$ in our framework, are capturing actual pull or push factors, gravity or network effects, but also residual errors or biases when the model is misspecified. We look at the variation underlying these residual terms in Table E.3. Panel A regresses the bilateral migration costs obtained across the different models onto a set of observable predictors for these migration frictions: (i) the rent at destination as a placebo variable that should not be predictive outside of its indirect effect through real wages, (ii) the wage of migrants at destination, (iii) distance between origins and destinations to capture the iceberg costs of migration, (iv) pollution at destination (Chen et al. 2017, Khanna et al. 2021), and (v) population at destination in 2000 to capture fixed amenities (e.g., other environmental or cultural factors). Models 1 and 2 fail to restrict the effect of housing prices to its impact through real wages (see columns 1 and 2)—a feature that we attribute to their failure to account for displaced consumption and the fact that migrants only allocate about 20% of their income to housing (versus 28% for residents). Model 3 indeed neutralizes the correlation between bilateral migration costs and rents at destination, and displays expected correlations with all the other variables. Model 4 introduces heterogeneity across migration modes (column 4 for migrants leaving family behind and column 5 for migrants with family at destination). However, because it ignores substitutability across migration modes, any factor favoring one migration mode will appear in both bilateral costs, positively in one and negatively in the other. The impact of such misspecification is made salient through the observed gaps across migration modes in the estimates for rents, wages, or population—a gap that we do not observe in our baseline model (columns 6 and 7). We interpret these findings as supportive evidence for Model 3 and our baseline model. Model 3 nonetheless cannot shed light on the importance of family migration (or the absence of family migration) in explaining the impact of restrictions in China, as we will see next.

We then evaluate the role of migration policies in shaping the extent of migration in China through the lens of these alternative models. We first isolate the causal effect of migration policies on the various inferred bilateral costs, in the manner of Table 8 (columns 1 and 2), and report the estimates in Panel B of Table E.3. We then simulate

Table E.3. Identifying migration frictions—alternative models.

	Model 1	Model 2	Model 3	Model 4		Baseline	
Bilateral migration costs	τ^1_{ru}	τ^2_{ru}	τ^3_{ru}	τ^4_{1ru}	τ^4_{2ru}	τ_{1ru}	τ_{2ru}
Panel A: explaining migration frictions							
Rent (log)	-0.234	-0.237	-0.037	-0.071	0.132	-0.029	-0.048
	(0.073)	(0.121)	(0.117)	(0.103)	(0.093)	(0.116)	(0.143)
Migrant wage (log)	0.729	0.524	0.489	0.140	1.547	0.391	0.617
	(0.208)	(0.308)	(0.290)	(0.284)	(0.523)	(0.292)	(0.297)
Distance (log)	0.189	0.109	0.146	0.231	0.262	0.149	0.230
	(0.032)	(0.069)	(0.061)	(0.032)	(0.046)	(0.058)	(0.061)
Pollution (log)	0.129	0.150	0.145	0.083	0.280	0.133	0.216
	(0.033)	(0.045)	(0.043)	(0.045)	(0.070)	(0.044)	(0.048)
Population (log, 2000)	0.060	0.158	0.148	0.156	-0.207	0.155	0.062
	(0.034)	(0.052)	(0.051)	(0.048)	(0.066)	(0.051)	(0.062)
Observations	1,864	1,864	1,864	1,864	1,864	1,864	1,864
Migration mode	-	-	-	$j = 1$	$j = 2$	$j = 1$	$j = 2$
	Model 1	Model 2	Model 3	Model 4		Baseline	
Bilateral migration costs	τ^1_{ru}	τ^2_{ru}	τ^3_{ru}	τ^4_{1ru}	τ^4_{2ru}	τ_{1ru}	τ_{2ru}
Panel B: the causal effect of migration policies							
Hukou conversion	-2.686	-4.266	-5.596	-5.361	-9.696	-6.164	-9.294
	(1.871)	(2.198)	(2.166)	(2.093)	(2.820)	(2.338)	(2.977)
Observations	3,586	3,586	3,586	3,113	1,613	3,113	1,613
Migration mode	-	-	-	$j = 1$	$j = 2$	$j = 1$	$j = 2$
F-stat	9.62	9.62	9.62	9.83	9.90	9.83	9.90

Notes: A unit of observation is a destination/origin pair within the connected set. Standard errors are clustered at the level of destinations and are reported between parentheses. The specification uses population weights in 2000 in both panels. The dependent variables are the model-computed bilateral costs of migration computed in the baseline (last two columns) and four alternative models of location choice. Model 1 has only one nest and one elasticity λ. Model 2 has two nests: the upper nest between migrating or staying and the lower nest across destinations for households who decide to emigrate. The previous models assume away heterogeneity in family migration (or not), and construct real wages across destinations without allowing for displaced consumption. Model 3 is similar to Model 2, except for real wages that are calculated using the average remittance share. Model 4 is designed and estimated like our baseline model (three nests allowing for two migration modes and different remittance behaviors), except for one component: we shut down the substitution across migration modes by imposing that $1/\mu = 0.4$. Panel A regresses the model-computed bilateral costs of migration on (log) rent in 2005, (log) migrant wage in 2005, (log) distance between origins and destinations, (log) pollution (2001–2005), and (log) population in 2000. Panel B replicates the causal analysis of Table 8 (columns 1 and 2).

the counterfactual experiment (2a) in all these alternative models and report their effect on migration numbers in Table E.4. All models naturally predict a very significant

Table E.4. The role of migration frictions in shaping migration—alternative models.

	Migrant households (millions)		
	All	No family	Family
Baseline	27,29 *1.573*	22,27	5,02
Counterfactual (2a)—Model 1	49,49 *1.868*		
Counterfactual (2a)—Model 2	42,96 *2.089*		
Counterfactual (2a)—Model 3	50,81 *2.147*		
Counterfactual (2a)—Model 4	87,64 *2.091*	69,95	17,68
Counterfactual (2a)—Baseline model	58,10 *2.123*	40,64	17,46

Notes: This Table reports statistics on the extent, nature, and consequences of migration flows in the baseline and in counterfactual experiment (2a). Across all experiments, we report the number of migrant households (overall in column 1, without family in column 2, with family in column 3, all reported in millions of migrant households between 2000 and 2005) and the elasticity of migrant concentration to the rent at destination in italics—as previously illustrated in panel (b) of Figure 2. The counterfactual experiment is simulated across four alternative models of location choice (as well as our baseline model). Model 1 has only one nest and one elasticity λ. Model 2 has two nests: the upper nest between migrating or staying and the lower nest across destinations for households who decided to emigrate. The previous models assume away heterogeneity in family migration (or not), and construct real wages across destinations without allowing for displaced consumption. Model 3 is similar to Model 2, except for real wages that are calculated using the average remittance share. Model 4 is designed and estimated like our baseline model (three nests allowing for two migration modes and different remittance behaviors), except for one component: we shut down the substitution across migration modes by imposing that $1/\mu$ is small.

uptick in migration with an increase in migrant concentration toward more expensive, restrictive cities. For instance, 50 million migrant households would leave their origins in Model 3 against 58 million in our preferred model, with a similar concentration across cities. What Model 3 misses is that family migration becomes much more attractive following the reform, leading to a disproportionate increase in this migration mode. This explains the missing 8 million migrant households, but also the composition of such missing households. Model 4 does account for the two types of migration and does allow for a differential effect of policies on bilateral costs (see Panel B of Table E.3), but it ignores substitutability between these modes implying that the expansion of family migration does not hinder the emigration of migrants without family. Model 4 thus predicts too large an adjustment following the relaxation of policies, with about 30 million additional migrant households, most of them leaving without their family.

In summary, our quantitative model of location choice does not only provide qualitative insights about the nature of migration in transforming economies; it also has quantitative implications for the effect of various migration frictions (including the endogenous frictions related to migration policies) on the spatial allocation of population across space.